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Marshall Space Flight Center, Alabama 35812

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MSFC EMI Test Facility (METF)

EMI/EMC Facility Operating Procedure For

SSP30237 Rev H

Baseline
May 1, 2006

MSFC Engineering Directorate

Instrument and Payload Systems Department
Electrical Design and Integration Division
Electromagnetic Environmental Effects (E3)
and Electrical Integration Branch
EI24

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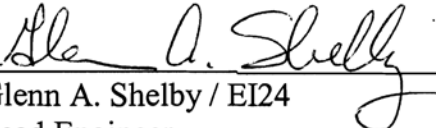
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1. INTRODUCTION

1.1 Purpose.

This procedure establishes the requirements and test operations necessary to prepare and operate the MSFC EMI Test Facility (METF), and to perform International Space Station (ISS) EMI testing to the requirements of SSP30237. The SSP30237 EMI testing utilizes SSP30238 test procedures in support of EMI qualification and development testing as defined by the Customer Agreement Form (CAF), MSFC Form 4404, submitted by appropriate test requestors.

1.2 Responsibilities.

The operation of this facility and the performance of this facility operating procedure (FOP) shall be conducted or coordinated by the assigned personnel of the Marshall Space Flight Center, Engineering Directorate, Instrument and Payload System, Electrical Design and Integration Division, Electromagnetic Environmental Effects (E3) Team, EI24.

It is the responsibility of the customer test requestors to define EMI/EMC requirements and services desired and to submit these requests using MSFC Form 4404, EMI Test CAF. EI24 personnel are available to assist in determining the EMI/EMC requirements if requested.

1.3 Emission and susceptibility designations.

The emissions and susceptibility and associated test procedure requirements in this standard are designated in accordance with an alphanumeric coding system. Each requirement is identified by a two-letter combination followed by a three digit number. The number is for reference purposes only. The meaning of the individual letters is as follows:

C = Conducted
R = Radiated
E = Emission
S = Susceptibility

- a. Conducted emissions requirements are designated by "CE---."
- b. Radiated emissions requirements are designated by "RE---."
- c. Conducted susceptibility requirements are designated by "CS---."
- d. Radiated susceptibility requirements are designated by "RS---."
- e. "---" = numerical order of requirement from 01 to 99.

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2. APPLICABLE DOCUMENTS

The following documents and reference documents of the date and issue shown form a part of this document to the extent specified herein.

2.1 Applicable Documents.

The following documents of the date and issue shown form a part of this document to the extent specified herein.

EI24-002 (Current Issue)	Organizational Issuance, EI24 Electromagnetic Environmental Effects (E3) Team, EMI/PQ Testing
SSP30237 (Current Issue)	International Space Station, Space Station Electromagnetic Emission and Susceptibility Requirements
SSP30238 (Current Issue)	International Space Station, Space Station Electromagnetic Techniques

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2.2 Reference Documents.

The following documents are cited as reference documents.

ANSI C63.2	Standard for Instrumentation Electromagnetic Noise and Field Strength, 10kHz to 40GHz
ANSI C63.14	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40GHz
ANSI/NCSL Z540-1	General Requirements for Calibration Laboratories and Measuring and Test Equipment
ASTM E 380	Standard for Metric Practice (Department of Defense adopted)
IEEE C95.1-1991	Institute of Electrical and Electronic Engineers (IEEE) Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300GHz
ISO10012-1	Quality Assurance Requirements for Measuring Equipment
MWI 8730.5	Control of Inspection, Measuring, and Test Equipment
SAE ARP 958	Electromagnetic Interference Measurement Antennas, Standard Calibration Requirements and Methods

2.3 Order of precedence.

In the event of a conflict between the text of this FOP and the references cited herein, the text of this FOP takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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3. ACRONYMS

Acronyms used in this facility operating procedure.

- a. ANSI - American National Standards Institute
- b. AR - Amplifier Research Corporation
- c. AWG - American Wire Gauge
- d. BIT - Built-in Test
- e. CAF - Customer Agreement Form
- f. COTS - Commercial Off-The-Shelf
- g. CSP- Customer Supplied Product
- h. CW - Continuous Wave
- i. dB - decibel
- j. EMC - Electromagnetic Compatibility
- k. EME - Electromagnetic Environment
- l. EMI - Electromagnetic Interference
- m. EMICP - Electromagnetic Interference Control Procedures
- n. EMITP - Electromagnetic Interference Test Procedures
- o. EMITR - Electromagnetic Interference Test Report
- p. EPO - Emergency Power Off
- q. ERP - Effective Radiated Power
- r. ESD - Electrostatic Discharge
- s. EUT - Equipment Under Test
- t. GFE - Government Furnished Equipment
- u. GSE - Ground Support Equipment
- w. FCC - Federal Communications Commission
- x. FET - Field Effect Transistor
- y. FOP - Facility Operating Procedure
- z. ILC - Interconnecting Leads and Cables
- aa. ISO - International Standards Organization

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ab. ISS	-	International Space Station
ac. LED	-	Light Emitting Diode
ad. LISN	-	Line Impedance Simulation Network
ae. METF	-	MSFC EMI Test Facility
af. MSFC	-	Marshall Space Flight Center
ag. MPR	-	Marshall Procedural Requirements
ah. MWI	-	Marshall Work Instruction
ai. NDI	-	Non-Developmental Item
aj. NTIA	-	National Telecommunications and Information Administration
ak. NIST	-	National Institute of Standards and Technology
al. ORU	-	Orbital Replacement Unit
am. PPE	-	Personnel Protective Equipment
an. RF	-	Radio Frequency
ao. R&S	-	Rohde & Schwartz Corporation
ap. RPCM	-	Remote Power Control Module
aq. RMS	-	Root Mean Square
ar. SAE	-	Society of Automotive Engineers
as. TILE	-	Total Integrated Laboratory Environment software
at. VSWR	-	Voltage Standing Wave Ratio

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4. SAFETY/QUALITY ASSURANCE INFORMATION

4.1 General safety requirements.

Each individual participating in METF Facility and EMI/EMC test operations is responsible for compliance with safety regulations.

Normal safety procedures for laboratory environments as identified in EI24-002 will be observed.

During radiated susceptibility test where high power levels of radio frequency (RF) energy are being radiated through antennas to the equipment under test (EUT), it is mandatory that the doors of the shielded enclosure where the test is being conducted be closed and secured. This is a requirement to reduce to safe levels power densities that may exceed the maximum permissible exposure to personnel in the immediate area. Reference IEEE C95.1-1991 Standard for Safety Levels with Respect to Human Exposure to RF Electromagnetic Fields, 3kHz to 300GHz.

4.2 Safety critical/hazardous operations.

No safety critical or hazardous operations are associated with this procedure.

4.3 Personnel protective equipment (PPE).

Any requirements for PPE during EMI/EMC testing that is unique to the EUT is to be identified by the customer in the customer agreement process and will be the responsibility of the customer.

4.4 Hardware handling.

Handling of EUTs designated for EMI/EMC testing is the responsibility of the customer as mutually agreed upon in the Customer Agreement process.

4.5 Cleanliness Requirements.

The METF can be maintained as an environmentally controlled test area to 300K clean room requirements. However, normal test operations do not require the 300K requirements. If 300K clean room requirements are required for a particular EUT, that requirement shall be coordinated as part of the customer agreement form.

4.4 Electrostatic Discharge (ESD) Requirements.

If an EUT designated for EMI/EMC testing is identified as ESD sensitive, then it is the responsibility of the customer to identify all areas of ESD sensitivity, grounding requirements and special handling in the Customer Agreement process.

4.5 Grounding requirements.

The METF power distribution and grounding will be operated to the terms identified in the appropriate sections of the standards, specifications and requirements of EMI/EMC testing. Specific power supply grounding or ground isolation is to be identified by the test customer in the Customer Agreement process.

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4.6 Electrical conventions.

The following color conventions will be used on test leads during the course of EMI/EMC testing and on EUT operations and setup.

Earth or structural ground	Green
DC common or return	Black or Green (if tied to earth or structural ground)
DC voltages above ground	Red
DC voltages below ground	Yellow

4.7 Emergency telephone numbers.

Fire	911
Ambulance	911
Security	4-4357 Option 1
Facilities	4-4357 Option 4

4.8 Emergency shutdown procedures.

In case of an emergency, perform the emergency shutdown procedures listed in Section 4.9.

In the event of severe weather during test operations, perform the emergency shutdown procedure and proceed immediately to the proper shelter area.

The 4708 building manager will make every effort to advise the METF and EUT operators of any planned fire drills. If properly notified, testing may continue during a planned fire drill. However, if the fire alarm sounds and it cannot be verified that a fire drill is taking place, perform the emergency shutdown procedure, then evacuate the METF and building 4708 to the designated EI24 marshalling area.

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4.9 EMERGENCY PROCEDURES

The following operational conditions could constitute an emergency condition requiring immediate attention or power removal.

- EUT exceeds normal operational current limits.
- Electrical problems resulting in visible smoke, arcing, sparks, excessive heating, unusual sounds etc. with the EUT or with METF equipment

4.9.1 Power removal.

- Open EUT power supply circuit breakers.
- Turn off all EUT power supplies
- Turn off EUT Ground Support Equipment (GSE)
- Turn off METF test equipment
- In the event that an unexpected and complete METF shutdown is required, hit any of the red Emergency Power Off (EPO) switches located in the shielded enclosure test areas as shown in Figure 1. This will shut down all power in the test chambers.

4.9.2 Water sprinkler deactivation.

Should an event occur where the smoke alarms have been falsely triggered, it will be necessary to deactivate the water sprinkler system. **NOTE: This action has to be accomplished within 30 seconds of the METF fire system alarm activation.**

At the Fire Alarm Abort switch directly in front of the METF entrance door, perform the following:

- Raise switch guard.
- Place switch to the up position to abort.
- Verify system aborted LED is on.

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5. GENERAL REQUIREMENTS

5.1 Definition of Electromagnetic Emission and Susceptibility Requirements

SSP30237 states that electronic, electrical, and electromechanical equipment and subsystems emissions and susceptibilities shall comply with the requirements found in SSP30237. Testing of the equipment to ensure compliance to the requirements of SSP30237 shall be performed using the test methods given in SSP30238.

5.1.1 Self-compatibility

SSP30237 states that the Equipment Under Test (EUT), designed in accordance with the Space Station Electromagnetic Compatibility (EMC) requirements, shall not malfunction and performance shall not be degraded during Electromagnetic Interference (EMI) testing.

5.1.2 Equipment emission and susceptibility limits

SSP30237 states that SSP30237 defines emission and susceptibility test limits for Space Station flight equipment and subsystems, including payloads. General EMI test techniques are contained in SSP30238. Approval of design procedures and techniques does not relieve the supplier of the responsibility of meeting the emission and susceptibility limits. A waiver is required for equipment which cannot meet the emission and susceptibility test requirements. The threshold of susceptibility shall be determined for equipment unable to meet the susceptibility test limits.

5.1.3 Conducted emissions

SSP30237 states that wiring between two or more Orbital Replacement Units (ORU) shall be exempt from the conducted emission test requirements provided the specific ORUs are tested as a single unit. Wiring external to the group of ORUs tested as a unit shall meet the test limit requirements of SSP30237..

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5.2 Documentation Requirements

5.2.1 Customer-prepared EMI Test Procedures (EMITP)

An EMITP should be prepared by the customer. The customer-prepared EMITP should contain the following:

- a. Introduction. The introduction of the EMITP should include the following:
 1. A table describing all the tests to be performed, the applicable section within the EMITP, and the corresponding test procedure from SSP30238..
 2. Description of the EUT, including its function, characteristics, intended installation, and power usage.
 3. Approved exceptions or deviations from contractual test requirements, if any.
- b. Applicable documents. Applicable documents should be listed as follows:
 1. NASA (such as standards and specifications).
 2. Military (such as standards and specifications).
 3. Company (such as in-house documents use for calibration or quality assurance).
 4. Other government or industry standards, specifications, and documents.
- c. EUT setup. A description of the EUT setup for each test should cover the following:
 1. Physical layout of the cables and EUT.
 2. Cable types, characteristics, and construction details (see Paragraph 5.3.8.6).
 3. Position of the LISNs on the ground plane.
 4. Use of bond straps
 5. Description of EUT loads.
 6. EUT simulation and monitoring equipment.
 7. The version of the software and firmware loaded into the EUT.

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- d. EUT operation. A description of the EUT operation should cover the following:
 1. Modes of operation for each EMI subtest, including operating frequencies (where applicable), and rationale for selection of each mode.
 2. Control settings on the EUT.
 3. Control settings on any test stimulation and monitoring equipment and characteristics of input signals.
 4. Operating frequencies (such as oscillator and clock frequencies) which may be expected to approach limits.
 5. Performance checks initiated to designate the equipment minimal working standard requirements.
 6. Enumeration of circuits, outputs, or displays to be monitored during susceptibility testing, as well as the criteria for determining degradation of performance.
- e. Measurements. The following should be described for each test.
 1. Block diagram depicting test setup, including all pertinent dimensions.
 2. Step-by-step procedures to operate the EUT for each EMI subtest.

5.2.2 Customer-prepared EMI Test Report (EMITR)

An EMITR should be prepared by the customer. The customer-prepared EMITR should contain the following:

- a.. Contract number.
- b. Authentication and certification of performance of the tests by a qualified representative of the procuring authority, if required.
- c. Disposition of the EUT.
- d. Description of the EUT, including its function, characteristics, intended installation, actual cable types (characteristics and construction details, reference Paragraph 5.3.8.6), and electrical current usage on each power input line.
- e. List of EMI tests performed with pass/fail indications.
- f. Any approved deviations from contractual test procedures or limits previously authorized.
- g. Identification of commercial off-the-shelf (COTS) and government furnished equipment (GFE) that may be part of the EUT.
- h. A reference to the approved customer-prepared EMITP.

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5.2.3 METF-prepared EMI Test Report (EMITR)

An EMITR shall be prepared by METF, unless the customer requests an EMITR not be prepared. The METF-prepared EMITR shall contain the following:

- a. A test summary including the following:
 1. An overall test summary and table of tests performed with pass/fail indications.
 2. A test results summary for each EMI subtest performed.
 3. A description of test requirements, setup, and test methods.
 4. A test run log spreadsheet identifying each EMI run with a run number, plot/print number, which EMI subtest was performed, METF software used, whether the run was a record or troubleshooting run, the applicable frequency range tested for that run, the equipment face tested, the EUT lead under test, the METF antenna orientation, the susceptibility level tested, an indication of pass/fail for the run, effects/observations during the run, and the EUT test configuration for the run.
 5. An METF test checklist detailing each EMI subtest performed, the test method, the METF software used, and the applicable test limit.
 6. Conclusions and recommendations. Conclusions and recommendations will be provided as applicable, including results of the test in brief narrative form, a discussion of any remedial EUT actions or modifications initiated during the test, and suggested corrective measures (if necessary) to assure compliance of the equipment or subsystem with the contractual EMI requirements.
- b. A copy of the completed and signed MSFC Form 4404 METF Customer Agreement Form (CAF)
- c. Applicable customer-provided documentation for the EUT, including (as a minimum) a copy of the as-run red-lined customer-prepared EMITP used during the test (if the customer provides an EMITP).
- d. The as-run red-lined MFOP-FA-EMI-305 EMI/EMC Facility Operating Procedure for SSP30237 Rev H including the following test equipment information for all calibrated equipment used during the test: equipment nomenclature, MSFC equipment calibration identification numbers, and the equipment calibration due date.

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- e. The test data, including the following:
 1. The ambient radiated and conducted electromagnetic emission profile of the METF, when necessary.
 2. Data, and data presentation, as specified in the “data presentation” sections of the individual test procedures of MFOP-FA-EMI-305.
 3. Scan speeds, if different than that specified in SSP30237/SSP30238.
 4. Measurement receiver bandwidths, if different than that specified in SSP30237/SSP30238.
 5. Antenna polarization.
 6. Power line voltages, frequencies, and power factor (where applicable).
 7. Any thresholds of susceptibility which were determined.
 8. A copy of the test run log from the test summary section.

- f. Captioned and labeled photographs of the actual test setup and EUT for each EMI subtest performed.

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5.3 Test Conditions

This section describes the test conditions specified in SSP30238.

5.3.1 Ambient electromagnetic level.

SSP30238 states that conducted and radiated ambient levels shall be at least 6 decibels (dB) below the applicable limits of SSP30237. Ambient conditions shall be determined prior to the beginning of measurements on the energized EUT.

5.3.2 Ground plane.

SSP30238 states that a solid plate copper or brass ground plane shall be used. It shall have a minimum thickness of 0.25 millimeter (mm) for copper or 0.63mm for brass and be 2.25 square meters or larger in area with the smaller side no less than 76 cm in length. When testing is performed in a shielded enclosure, the ground plane shall be bonded to the shielded enclosure such that the direct current (dc) bonding resistance shall not exceed 2.5 milliohms. In addition, the bonds shall be placed at distances no greater than 90 cm apart. For large equipment mounted on a metal test stand, the test stand shall be considered a part of the ground plane for testing purposes and shall be bonded accordingly.

Each METF test chamber has a non-conductive EUT test table with 90cm height. The tabletop is completely covered by 1/8" copper stock. The copper tabletop is bonded to the shielded enclosure every 35.5" with 1/16" copper stock straps which are 12" wide and less than 59" long. This provides a good RF bond between the test tabletop and the shielded enclosure. The nominal tabletop size is 8 ft long by 3 ft wide, but can be extended to 12 ft long by 6 ft wide for large test items.

For EUTs with metal enclosures mounted to a metal structure in the actual equipment installation, the EUT is bonded to the copper table top using contact between the EUT and the tabletop and either a braided metal strap or copper tape. The bonding simulates the actual installation as closely as possible.

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5.3.3 Power supply characteristics.

SSP30238 states that the power supplies for test samples requiring a power source for its operation and not supplied as part of the equipment shall have characteristics and tolerances within the limits of SSP30482, Volume I.

METF utilizes two independent power supplies to provide dc power inside the test chambers. The power supplies are located in room E-20 on the second floor on top of the test chambers. The power supply feeds come down from the second floor to filters mounted on the outside of each test chamber. The first power supply is usually used to provide 120Vdc power. This supply is an Electronic Measurement Inc. model EMHP 300-100-41211, serial number 92K-1233 and is rated at 300V/100A. This power supply feeds into the chamber via Lectro Line (Lectrometrics Division of Lindgren RF Enclosures) LMX-UL-100A, 100A, 277VAC line to ground 50/60Hz (9244) filters on each power leg at the outer chamber wall of each chamber. The second power supply is usually used to provide 28Vdc power. This supply is an Electronic Measurement Inc model TCR 40570-2-D-OV (serial number 92H-7770) and is rated at 40V/70A. This power supply feeds into the chambers via Lectro Line (Lectrometrics Division of Lindgren RF Enclosures) LMX-UL-20A, 20A, 277VAC line to ground 50/60Hz (9244) filters on each power leg at the outer chamber wall of each chamber. 208VAC and 115VAC power is fed into the chambers via Lectro Line (Lectrometrics Division of Lindgren RF Enclosures) LMX-UL-60A, 60Amp, 277VAC line to ground 50/60Hz (9244) filters on each power leg at the outer chamber wall of each chamber.

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5.3.4 Radio Frequency (RF) absorber material.

SSP30238 states that RF absorber material may be used in shielded enclosures to reduce reflections from the surfaces of the enclosure to the measurement antennas for nonstirred mode tests only. Any use of RF absorber material shall be documented in the test report.

METF utilizes Advanced Electromagnetics Incorporated (AEMI) AEP-12 12 inch pyramidal absorber on all walls and ceiling in each test chamber. The absorption at normal incidence is plotted in Figure 3.

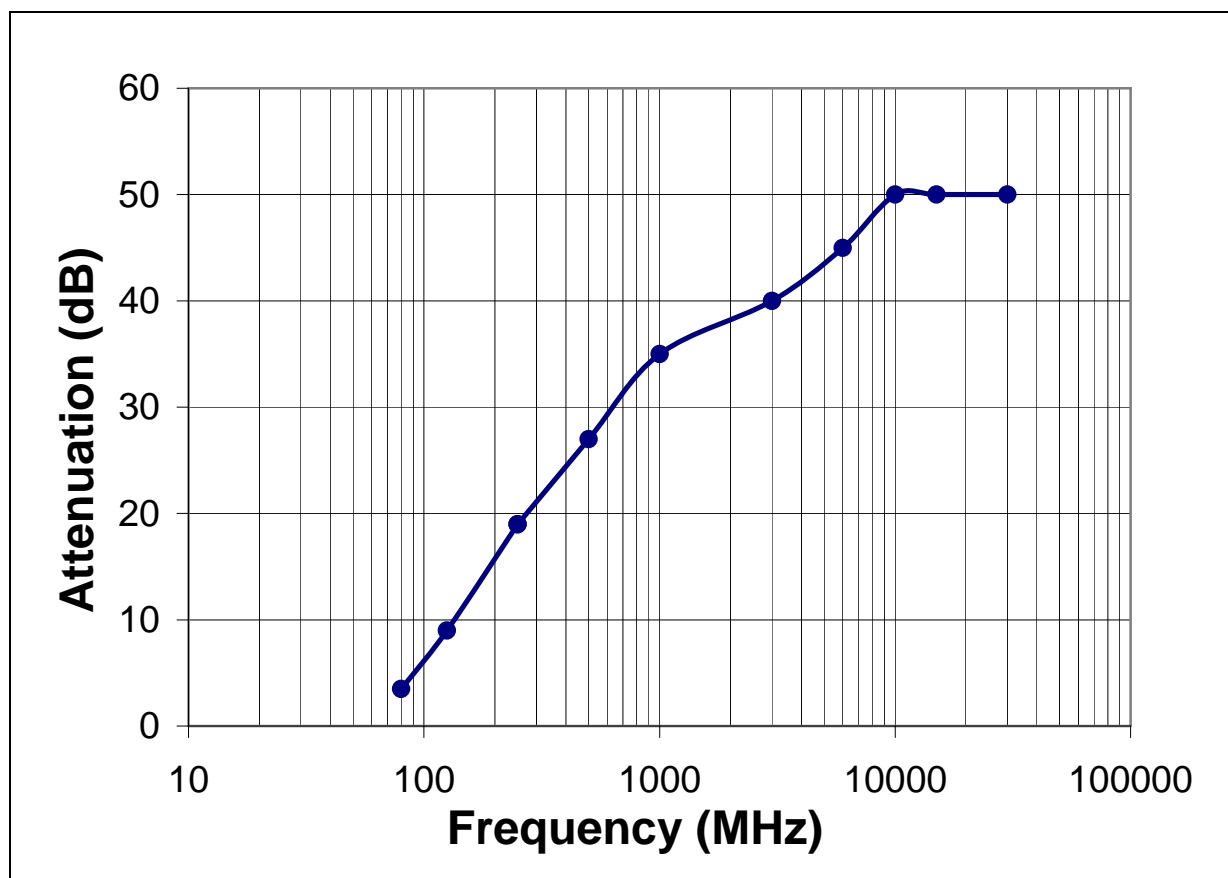


FIGURE 1. METF pyramidal absorber characteristics.

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5.3.5 Shielded enclosures.

SSP30238 states that shielded enclosures shall be of sufficient size to adequately accept the EUT without sacrificing test accuracy or requiring deviation from the methods specified in SSP30237. The characteristics of shielded enclosures shall be defined in the EMI test plan.

The MSFC EMI Test Facility (METF) is located in MSFC Building 4708 Room 1191. The facility consists of four shielded enclosures connected together as shown in Figure 1. The four shielded enclosures consist of a box level room, rack level room, instrumentation room, and an amplifier room. The large test chamber, used for testing systems and large test items, is 24 feet wide, 28 feet deep, and 20 feet high. This is designated as the rack shielded enclosure in Figure 1. The small test chamber, used for testing subsystems and small test items, is 20 feet wide, 28 feet deep, and 14 feet high. This is designated as the box shielded enclosure in Figure 1. The instrumentation room measures 12 feet wide, 18 feet deep, and 10 feet high. The amplifier room measures 12 feet wide, 10 feet deep, and 10 feet tall. All sides of each room are constructed of quarter inch steel plate.

The rack and box level chambers are fully lined with radio frequency (RF) absorber. The RF absorber characteristics are discussed in Section 5.3.4. Each test chamber has a large door for EUT delivery and a smaller personnel door. All doors are pneumatically sealed sliding doors that maintain the steel double-walled enclosure integrity. All door mating surfaces are flame sprayed with tin. Ceiling and wall penetrations include 21 sprinkler penetrations, 18 vent penetrations, 16 filter penetrations, and 5 access panels.

The box level and rack level shield room attenuation requirements are shown in Table II. The Instrumentation and Amplifier shield room attenuation requirements are shown in Table III. These requirements have been verified using the procedures of Specification NSA No. 65-6, National Security Agency Specification for R.F. Shielded Enclosures for Communications Equipment: General Specification. Both box level and rack level test chamber ambient RE02 levels are a minimum of 6dB below the SSP30237 limits.

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TABLE I. METF box and rack room attenuation requirements.

Frequency	Field Type	Attenuation (dB)
60 Hz	Magnetic	24
1 kHz	Magnetic	20
15 kHz	Magnetic	75
250 kHz	Magnetic	100
1 MHz	Magnetic	100
30 Hz	Electric	25
1 kHz	Electric	70
10 kHz	Electric	100
100 kHz	Electric	100
1 MHz	Electric	100
10 MHz	Electric	100
100 MHz	Plane Wave	100
400 MHz	Plane Wave	100
1 GHz	Plane Wave	100
12 GHz	Plane Wave	100

TABLE II. METF instrumentation and amplifier room attenuation requirements.

Frequency	Field Type	Attenuation (dB)
1 kHz	Magnetic	20
10 kHz	Magnetic	55
100 kHz	Magnetic	90
1 MHz	Magnetic	100
1 kHz	Electric	70
10 kHz	Electric	100
100 kHz	Electric	100
1 MHz	Electric	100
10 MHz	Electric	100
100 MHz	Plane Wave	100
400 MHz	Plane Wave	100
1 GHz	Plane Wave	100
12 GHz	Plane Wave	100

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5.3.6 Test site atmospheric conditions.

SSP30238 states that testing shall be performed under the following atmospheric conditions where possible:

- Temperature: 15 to 35 degrees Celsius
- Pressure: 610 to 780 mm Mercury
- Relative Humidity: 20 to 80 percent of saturation

5.4 Measuring Equipment

This section describes the test equipment used in the test methods contained in SSP30238.

5.4.1 Test antennas.

SSP30238 states that antennas used in performing radiated emission and susceptibility tests shall be documented. Receive antenna factors and methods used to establish radiated susceptibility environments shall be detailed in the test procedure and the EMI test plan. The antennas used for METF testing are documented in the respective sections of this FOP.

5.4.2 Use of measuring equipment.

SSP30238 states that all laboratory equipment shall be operated as prescribed by the applicable instruction manuals unless otherwise specified in SSP30238. SSP30238 shall take precedence in the event of conflict with instruction manuals or other documents issued by industry or other government agencies unless identified in an approved EMI test plan. For test repeatability, all test parameters used to configure the test shall be recorded in the EMI test plan and the EMI test report. These parameters shall include measurement bandwidths, video bandwidths, sweep speeds, etc.

5.4.3 Grounding of measurement equipment.

SSP30238 states to avoid false data that may be introduced by ground loops, test equipment shall be referenced to the same ground as the EUT. An equipment safety ground shall be maintained at all times, but for a specific test the ground power line may be broken means of an isolation transformer or isolation connectors. To avoid high frequency ground loops, test receivers for tests above 30 MHz shall be placed outside the test chamber.

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5.4.4 Measurement equipment warm-up time.

SSP30238 states that prior to performing tests, the measuring equipment shall be switched on for a period of time adequate to allow parameter stabilization. If the operation manual does not specify a specific warm-up time, the minimum warm-up period shall be one hour.

5.4.5 Measuring equipment calibration.

SSP30238 specifies that measuring instruments and accessories used in determining compliance with the SSP30238 shall be calibrated under an approved program in accordance with MIL-STD-45662.

METF equipment is calibrated under an the approved calibration program, delineated in MPR 8730.5, Control of Inspection, Measuring, and Test Equipment, that is traceable to NIST. In particular, measurement antennas, current probes, field sensors, and other devices used in the measurement loop are calibrated on an annual basis unless otherwise specified by the manufacturer, or when damage is apparent.

The METF equipment calibration list used to perform the test in this procedure is found in Appendix A.

5.4.6 Measurement accuracy.

SSP30238 states that the test equipment shall be capable of measuring to within the following accuracy:

- a. Frequency: $\pm 2\%$
- b. Amplitude: $\pm 3\text{dB}$

SSP30238 states that in the event that an above-specification signal emission is found in any of the specific frequency and amplitude ranges above 100MHz listed in SSP30237, the frequency of the offending signal shall be determined to an accuracy of 0.0002 percent.

5.4.7 Emission measurement bandwidths.

SSP30238 states that the measuring instrument bandwidth shall be less than one-third the lowest tuned frequency in the range for narrowband and less than one-half the lowest tuned frequency for optional broadband measurements. Optional broadband measurements should be made using bandwidths approximately ten times the narrowband bandwidth.

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5.4.7.1 METF Measurement bandwidths.

The MIL-STD-461E bandwidth and measurement times are used for all METF emissions testing, except where noted to conform to specific SSP30238 requirements. These bandwidth and measurement times have been coordinated with and approved by the ISS Electromagnetic Effects (EME) lead.

The METF measurement receiver bandwidths listed in Table V shall be used for emission testing. These bandwidths are specified at the 6 dB down points for the overall selectivity curve of the receivers. Video filtering shall not be used to bandwidth limit the receiver response. If a controlled video bandwidth is available on the measurement receiver, it shall be set to its greatest value. Larger receiver bandwidths may be used; however, they may result in higher measured emission levels. NO BANDWIDTH CORRECTION FACTORS SHALL BE APPLIED TO TEST DATA DUE TO THE USE OF LARGER BANDWIDTHS.

TABLE III. Bandwidth and measurement time.

Frequency Range	6 dB Bandwidth	Dwell Time	Minimum Measurement Time Analog Measurement Receiver
30 Hz - 1 kHz	10 Hz	0.15 sec	0.015 sec/Hz
1 kHz - 10 kHz	100 Hz	0.015 sec	0.15 sec/kHz
10 kHz - 150 kHz	1 kHz	0.015 sec	0.015 sec/kHz
150 kHz - 30 MHz	10 kHz	0.015 sec	1.5 sec/MHz
30 MHz - 1 GHz	100 kHz	0.015 sec	0.15 sec/MHz
Above 1 GHz	1 MHz	0.015 sec	15 sec/GHz

5.4.7.2 Emission identification.

SSP30238 states that the following guidelines govern the requirements for pulsed continuous wave interference:

- Narrowband limits shall be used
- Bandwidth correction factors shall not be used.

The following statement from MIL-STD-461E elaborates on the SSP30238 requirement: all emissions regardless of characteristics shall be measured with the measurement receiver bandwidths specified in Table V and compared against the applicable limits. Identification of emissions with regard to narrowband or broadband categorization is not applicable.

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5.4.7.3 Frequency scanning.

MIL-STD-461E states that for emission measurements, the entire frequency range for each applicable test shall be scanned. Minimum measurement time for analog measurement receivers during emission testing shall be as specified in Table V. Synthesized measurement receivers shall step in one-half bandwidth increments or less, and the measurement dwell time shall be as specified in Table V. For equipment that operates such that potential emissions are produced at only infrequent intervals, times for frequency scanning shall be increased as necessary to capture any emissions. For equipment which operates for very short durations, or which has a limited life, scan times may be reduced. Justification for such reduction will be presented in the customer-prepared EMITP, and approved by the designated approving authority prior to test.

5.4.7.4 Emission data presentation.

MIL-STD-461E states that amplitude versus frequency profiles of emission data shall be automatically generated and displayed at the time of test and shall be continuous. The displayed information shall account for all applicable correction factors (transducers, attenuators, cable loss, and the like) and shall include the applicable limit. Manually gathered data is not acceptable except for verification of the validity of the output. Plots of the displayed data shall provide a minimum frequency resolution of 1% or twice the measurement receiver bandwidth, whichever is less stringent, and minimum amplitude resolution of 1 dB. The above resolution requirements shall be maintained in the reported results of the METF-prepared EMITR.

5.4.7.8 Detector.

SSP30237 explicitly specifies a peak detector for RE02 and is silent on the detector to use for all other emissions tests. MIL-STD-461E state that a peak detector shall be used for all frequency domain emission and susceptibility measurements. This device detects the peak value of the modulation envelope in the receiver bandpass. Measurement receivers are calibrated in terms of an equivalent Root Mean Square (RMS) value of a sine wave that produces the same peak value. When other measurement devices such as oscilloscopes, non-selective voltmeters, or broadband field strength sensors are used for susceptibility testing, correction factors shall be applied for test signals to adjust the reading to equivalent RMS values under the peak of the modulation envelope. A peak detector is used for all METF measurements to follow MIL-STD-461E guidance.

5.4.8 Susceptibility testing.

This section describes the general susceptibility testing parameters used in the METF.

5.4.8.1 Frequency scanning.

SSP30238 does not specify frequency step sizes or scan rates for susceptibility testing. Modified MIL-STD-461E susceptibility scanning parameters are used for all METF susceptibility testing. These scan parameters have been coordinated with and approved by the ISS Electromagnetic Effects (EME) lead.

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MIL-STD-461E states that for susceptibility measurements, the entire frequency range for each applicable test shall be scanned. For swept frequency susceptibility testing, frequency scan rates and frequency step sizes of signal sources shall not exceed the values listed in Table IV. The rates and step sizes are specified in terms of a multiplier of the tuned frequency (f_o) of the signal source. Analog scans refer to signal sources which are continuously tuned. Stepped scans refer to signal sources which are sequentially tuned to discrete frequencies. **Stepped scans shall dwell at each tuned frequency for the greater of 3 seconds or the EUT response time.** Scan rates and step sizes shall be decreased when necessary to permit observation of a response.

TABLE IV. Susceptibility scanning.

Frequency Range	Analog Scans Maximum Scan Rates	Stepped Scans Maximum Step Size
30 Hz - 1 MHz	$0.0333f_o/\text{sec}$	$0.05 f_o$
1 MHz - 18 GHz	$0.00667 f_o/\text{sec}$	$0.01 f_o$

5.4.8.2 Modulation of susceptibility signals.

Susceptibility modulation requirements are located with each susceptibility test requirement.

5.4.8.3 Thresholds of susceptibility.

METF utilizes the following susceptibility threshold determination procedure from MIL-STD-461E, to better define the SSP30238 susceptibility threshold procedure. When susceptibility indications are noted in EUT operation, a threshold level shall be determined where the susceptible condition is no longer present. Thresholds of susceptibility shall be determined as follows and described in the EMITR:

- When a susceptibility condition is detected, reduce the interference signal until the EUT recovers.
- Reduce the interference signal by an additional 6 dB.
- Gradually increase the interference signal until the susceptibility condition reoccurs. The resulting level is the threshold of susceptibility.
- Record this level, frequency range of occurrence, frequency and level of greatest susceptibility, and other test parameters, as applicable.

5.4.9 Measurement system test.

METF utilizes the MIL-STD-461E measurement system test procedure to ensure that all METF emissions measurement systems are operating correctly. At the start of each emission test, the

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complete test system (including measurement receivers, cables, attenuators, couplers, and so forth) shall be verified by injecting a known signal, as stated in the individual test procedure, while monitoring system output for the proper indication. When the emission test involves an uninterrupted set of repeated measurements (such as evaluating different operating modes of the EUT) using the same measurement equipment, the measurement system test needs to be accomplished only one time.

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5.4.10 Measurement antenna position.

5.4.10.1 Equipment under test evaluation.

SSP30238 states that the following face probing technique shall be applicable only to large, rack mounted EUTs. EUTs mounted on a ground plane arranged with their interconnecting cables in accordance with the requirements of SSP30238 need not be probed. Whenever possible, each EUT shall be mounted so as to have the face with the most connectors facing the measurement antenna. Each face of the EUT shall be probed with a loop or other suitable sensor to determine the localized area producing maximum emission or susceptibility. Probing shall be performed at frequencies known or calculated to represent worst case interference; if no such information is available, probing shall be performed at no fewer points than one frequency for every two octaves over the frequency range of test. The face exhibiting worst case characteristics in any octave or band, provided that the band is not less than two octaves, shall face the test antenna for that portion of the frequency scan. Automatic scan techniques may be used to scan all sides.

5.4.10.2 Antenna location.

SSP30238 states that when performing emission and susceptibility tests, no points of the antennas shall be less than 30 cm from the floor and ceiling and 1 meter from the walls of the shielded enclosure or obstruction.

5.4.10.3 Antenna polarization.

SSP30238 states that for radiated emission measurements above 30 MHz, linearly polarized antennas shall be positioned to measure the vertical and horizontal components of the emission. For radiated susceptibility measurements above 30 MHz, linearly polarized test antennas shall be positioned so as to generate vertical and horizontal fields.

METF performs emissions and susceptibility measurements above 30 MHz in both vertical and horizontal antenna polarizations.

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5.5 Arrangement and operation of equipment under test.

This section describes the EUT operating modes and test configuration used in the test methods contained in SSP30238.

5.5.1 EUT design status.

MIL-STD-461E states that EUT hardware and software shall be representative of production. Software may be supplemented with additional code that provides diagnostic capability to assess performance.

5.5.2 EUT Operation and control adjustment.

SSP30238 states that for a representative set of modes of operation, controls on the EUT shall be operated and adjusted as prescribed in the instruction manual or as required by the equipment specification to obtain optimum performance. For susceptibility tests, the most susceptible modes shall be selected. For emission tests, the noisiest modes shall be selected. Specific mode selection criteria and software used to operate the EUT shall be documented in accordance with the requirements of SSP30243.

MIL-STD-461E states that for EUTs with several available modes (including software controlled operational modes), a sufficient number of modes shall be tested for emissions and susceptibility such that all circuitry is evaluated. If production software or firmware is not available, justification shall be shown that the software or firmware used for the test is able to activate or exercise the EUT in a manner equivalent to production software or firmware. The rationale for modes selected should be included in the customer-prepared EMITP. A functional test of the EUT should be performed as a minimum before and after the entire test series.

5.5.3 EUT signal inputs.

SSP30238 states that actual or simulated signal inputs and software required to activate, utilize, or operate a representative set of circuits shall be used during emission and susceptibility testing.

5.5.4 EUT arrangement.

SSP30238 states that interconnecting cable assemblies and supporting structures shall simulate actual installation and usage. Shielded leads used in the test setup shall be the same as specified in approved installation drawings. Diagrams of the cables which interconnect EUTs shall be documented. Cables and equipment shall not be interposed between the EUT cables and the measurement antennas. When testing within a shielded enclosure, one face of the box comprising the EUT shall be located within 10 cm from the ground plane edge nearest the measurement antenna. All leads and cables shall be located within 10 cm from the ground plane edge nearest the measurement antenna and shall be supported at least 5 cm above the ground plane on

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nonconductive spacers. Power cable configurations shall simulate actual installation with minimum breakout for use with current probes near feed through capacitors.

MIL-STD-461E states that the EUT shall be configured as shown in the general test setups of Figures 1 through 5 as applicable. These setups shall be maintained during all testing unless other direction is given for a particular test procedure.

Further EUT arrangement guidance from MIL-STD-461E is included below.

5.5.4.1 Orientation of EUTs.

MIL-STD-461E states that EUTs shall be oriented such that surfaces which produce maximum radiated emissions and respond most readily to radiated signals face the measurement antennas. Bench mounted EUTs shall be located 10 ± 2 centimeters from the front edge of the ground plane subject to allowances for providing adequate room for cable arrangement as specified below.

5.5.4.2 Construction and arrangement of EUT cables.

MIL-STD-461E states that electrical cable assemblies shall simulate actual installation and usage. Shielded cables or shielded leads (including power leads and wire grounds) within cables shall be used only if they have been specified in installation requirements. Cables shall be checked against installation requirements to verify proper construction techniques such as use of twisted pairs, shielding, and shield terminations. Details on the cable construction, such as wire types, lengths, pigtail lengths, shield termination, lengths of ground wires, and ground locations, used for testing shall be included in the customer-prepared EMITP.

5.5.4.3 Interconnecting leads and cables.

MIL-STD-461E state that individual leads shall be grouped into cables in the same manner as in the actual installation. Interconnecting cable lengths in the test setup shall represent the actual lengths in the vehicle, unless the actual vehicle lengths are less than that allowed to meet the following conditions. Cable lengths, when not specified for the installation, shall be sufficiently long to achieve a two meter run along the ground plane edge. At least the first 2 meters of each interconnecting cable associated with each enclosure of the EUT shall be run parallel to the front boundary of the setup. Remaining cable lengths shall be routed to the back of the setup and shall be placed in a zigzagged arrangement. When the setup includes more than one cable, individual cables shall be separated by 2 centimeters measured from their outer circumference. For bench top setups using ground planes, cables shall be placed 10 centimeters from the front edge of the ground plane. All cables shall be supported 5 centimeters above the ground plane.

5.5.4.4 Input power leads.

MIL-STD-461E states that two meters of input power leads (including neutrals and returns) shall be routed parallel to the front edge of the setup in the same manner as the interconnecting leads. Each input power lead, including neutrals and returns, shall be connected to a 10uF feed-through capacitor. Power leads that are bundled as part of an interconnecting cable in the actual installation shall be configured in the same fashion for the 2 meter exposed length and then shall

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be separated from the bundle and routed to the feed-through capacitors. After the 2 meter exposed length, the power leads shall be terminated at the feed-through capacitors in as short a distance as possible. The total length of power lead from the EUT electrical connector to the feed-through capacitors shall not exceed 2.5 meters. All power leads shall be supported 5 centimeters above the ground plane. If the power leads are twisted in the actual installation, they shall be twisted up to the feed-through capacitors.

5.5.4.5 Electrical and mechanical interfaces.

SSP30238 states that the EUT shall be loaded with the full mechanical and electrical load or equivalent for which it is designed. If worst case EMI conditions exist at a reduced load, the tests shall include the reduced level loads as well as the full load. This requirement specifically includes electrical loading of the contacts of mechanisms which are designed to control electrical loads even though such loads are physically separate from the EUT. Operation of voltage regulators and other circuits that function intermittently shall be required during testing. The loads used shall simulate the impedance of the actual load. Mechanical devices shall be operated under load. The EUT shall be actuated by the same means as in the installation. As an example, if a solenoid is actuated by a silicon controlled rectifier, a toggle switch shall not be used to operate the solenoid for the test.

MIL-STD-46E states that when active electrical loading (such as a test set) is used, precautions shall be taken to insure the active load meets the ambient requirements of Paragraph 5.3.1 when connected to the setup, and that the active load does not respond to susceptibility signals.

5.5.4.6 Source and loads for communications-electronics equipment.

SSP30238 states that all RF outputs of communications electronics equipment shall be terminated with shielded dummy loads as appropriate for the EUT and the test being performed, to produce maximum normal output. At frequencies of concern, the Voltage Standing Wave Ratio (VSWR) of resistive dummy loads, attenuators, directional couplers, samplers, power dividers, and the internal output impedance of standard signal generators shall be no greater than:

- Transmitter loads: 1.5:1
- All other dummy loads and pads: 1.3:1
- Standard signal generators: 1.3:1

SSP30238 states that the use of standard signal generators shall be defined in the equipment list of the customer test procedure.

5.5.4.7 Bonding and grounding of equipment under test.

SSP30238 states that bonding of the EUT for tests shall be in accordance with the approved installation drawings for the equipment. When bonding straps are required to complete the test setup, they shall be the same as those specified in the installation drawings. Portable equipment shall be grounded by the third wire of the power cable. Physical isolation of the portable

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equipment chassis from structure shall be required for testing. Bonding provisions used for all testing shall be documented in the METF-prepared EMI test report.

5.5.4.8 Shock and vibration isolators.

SSP30238 states that if the EUT is mounted on a base with shock or vibration isolators in the operational installation, the test setup shall include such mounting provisions. Bonding hardware and application for the EUT shall be identical to the approved installation drawing. If no provision for bond straps is made on the installation drawings, then no bond straps shall be used during testing.

5.5.4.9 External ground terminal.

SSP30238 states that when an external terminal is provided for a ground connection on the EUT, this terminal shall be connected to the ground plane. The conductor used for the connection shall be of similar dimensions and material to that shown on installation drawings (i.e. length, width, thickness, and diameter).

5.5.4.10 Operating frequencies for tunable RF equipment.

MIL-STD-461E states that measurements shall be performed with the EUT tuned to not less than three frequencies within each tuning band, tuning unit, or range of fixed channels, consisting of one mid-band frequency and a frequency within ± 5 percent from each end of each band or range of channels.

5.5.4.11 Operating frequencies for spread spectrum equipment.

MIL-STD-461E states that operating frequency requirements for two major types of spread spectrum equipment shall be as follows:

- a. Frequency hopping. Measurements shall be performed with the EUT utilizing a hop set which contains a minimum of 30% of the total possible frequencies. This hop set shall be divided equally into three segments at the low, mid, and high end of the EUT's operational frequency range.
- b. Direct sequence. Measurements shall be performed with the EUT processing data at the highest possible data transfer rate.

5.5.4.12 Susceptibility monitoring.

MIL-STD-461E states that the EUT shall be monitored during susceptibility testing for indications of degradation or malfunction. This monitoring is normally accomplished through the use of built-in-test (BIT), visual displays, aural outputs, and other measurements of signal outputs and interfaces. Monitoring of EUT performance through installation of special circuitry in the EUT is permissible; however, these modifications shall not influence test results.

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5.6 General test precautions.

5.6.1 Accessory equipment.

MIL-STD-461E states that accessory equipment used in conjunction with measurement receivers shall not degrade measurement integrity.

5.6.2 Excess personnel and equipment.

MIL-STD-461E states that the test area shall be kept free of unnecessary personnel, equipment, cable racks, and desks. Only the equipment essential to the test being performed shall be in the test area or enclosure. Only personnel actively involved in the test shall be permitted in the enclosure.

5.6.3 Overload precautions.

MIL-STD-461E states that measurement receivers and transducers are subject to overload, especially receivers without preselectors and active transducers. Periodic checks shall be performed to assure that an overload condition does not exist. Instrumentation changes shall be implemented to correct any overload condition.

5.6.4 RF hazards.

MIL-STD-461E states that some tests in this specification will result in electromagnetic fields which are potentially dangerous to personnel. The permissible exposure levels in IEEE C95.1-1991, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 Gigahertz (GHz), shall not be exceeded in areas where personnel are present. Safety procedures and devices shall be used to prevent accidental exposure of personnel to RF hazards.

5.6.5 Shock hazard.

MIL-STD-461E states that some of the tests require potentially hazardous voltages to be present. Extreme caution must be taken by all personnel to assure that all safety precautions are observed.

5.6.6 Federal Communications Commission (FCC) restrictions.

MIL-STD-461E states that all planned open site radiation tests (i.e. outside of shielded enclosures) shall be pre-coordinated and approved by the National Telecommunications and Information Administration (NTIA) and/or the FCC, whichever is applicable, regardless of the level of signals used. SL-E-0002 Book 3 Volume 1 states that authorization shall be secured prior to conducting the test readiness review. The test sponsor(s) and customers and the METF personnel shall contact the respective NASA Field Center Spectrum Manager at the earliest possible stage of the test planning with all pertinent RF systems parameters and configuration data to facilitate the authorization process.

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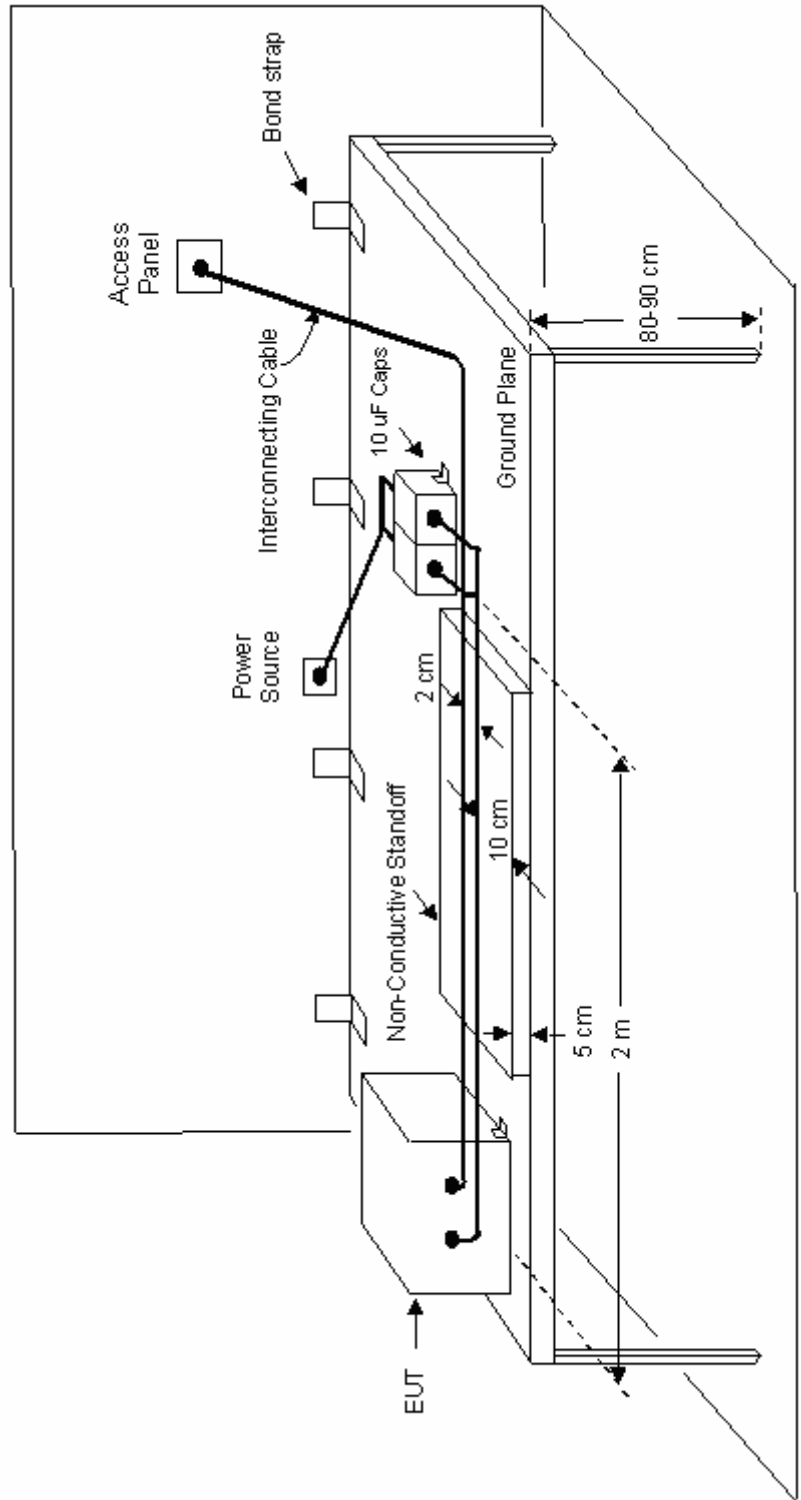


FIGURE 3. General test setup.

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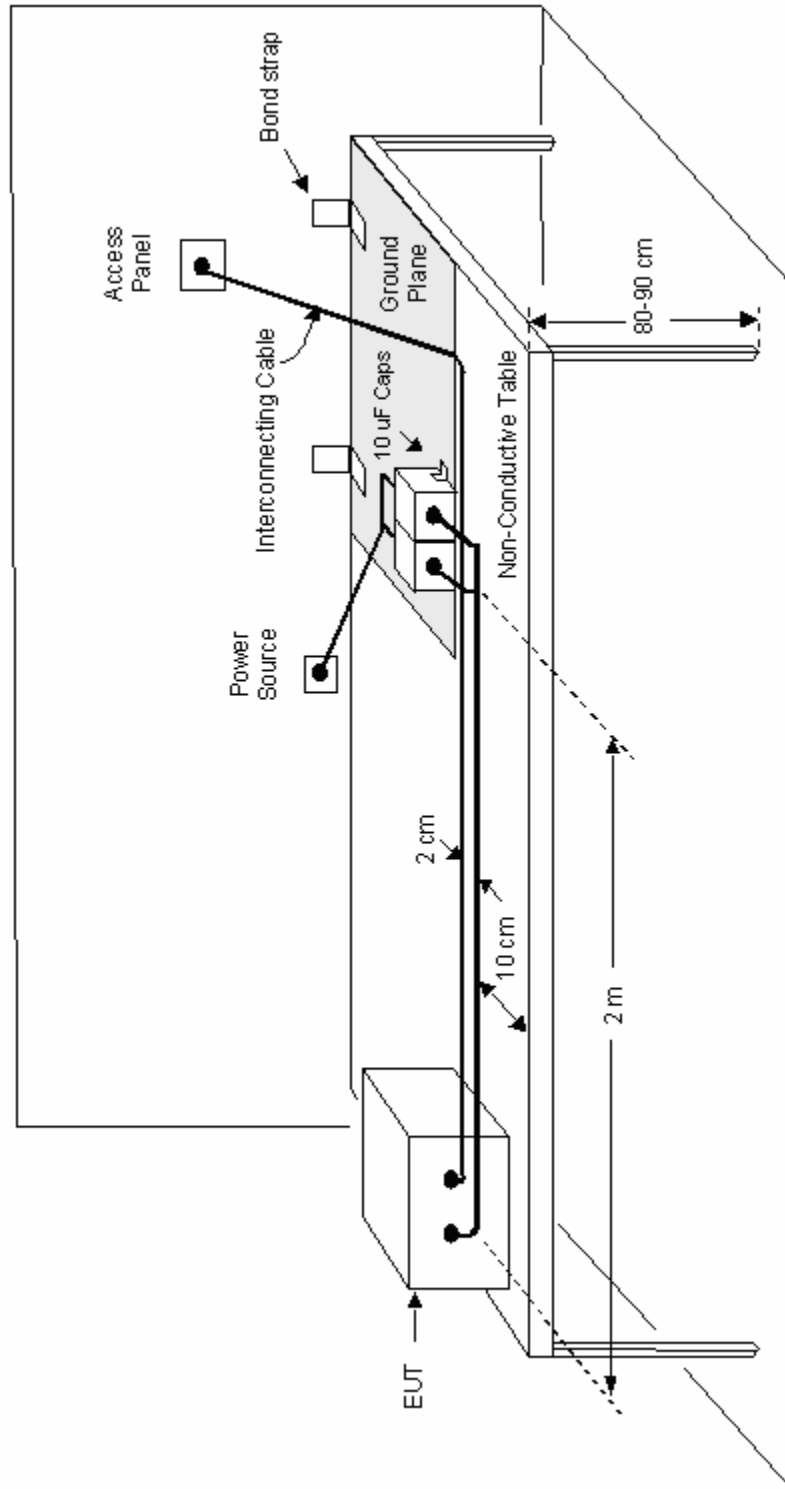


FIGURE 4. Test setup for non-conductive surface mounted EUT.

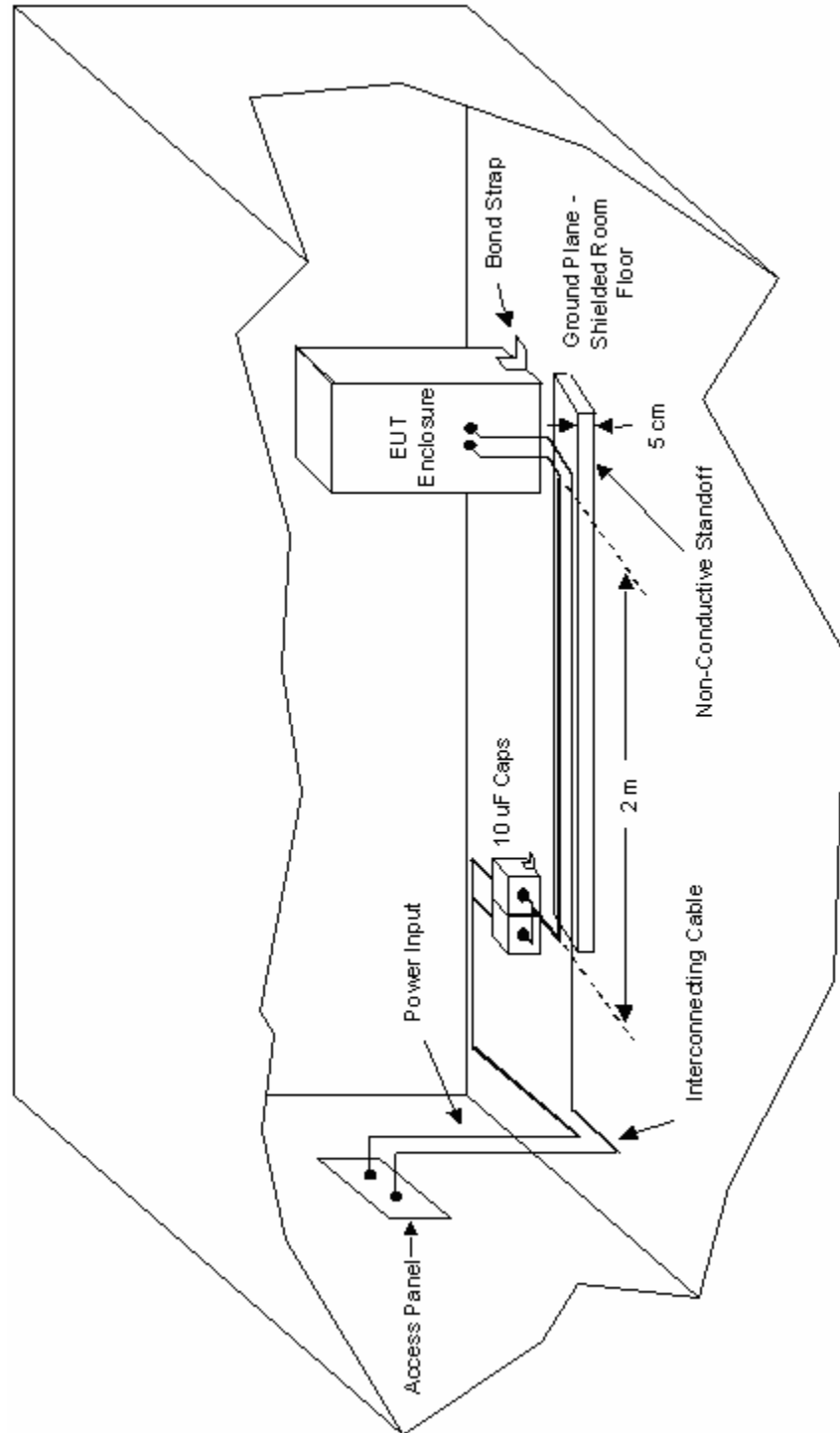


FIGURE 5. Test setup for free standing EUT in shielded enclosure.

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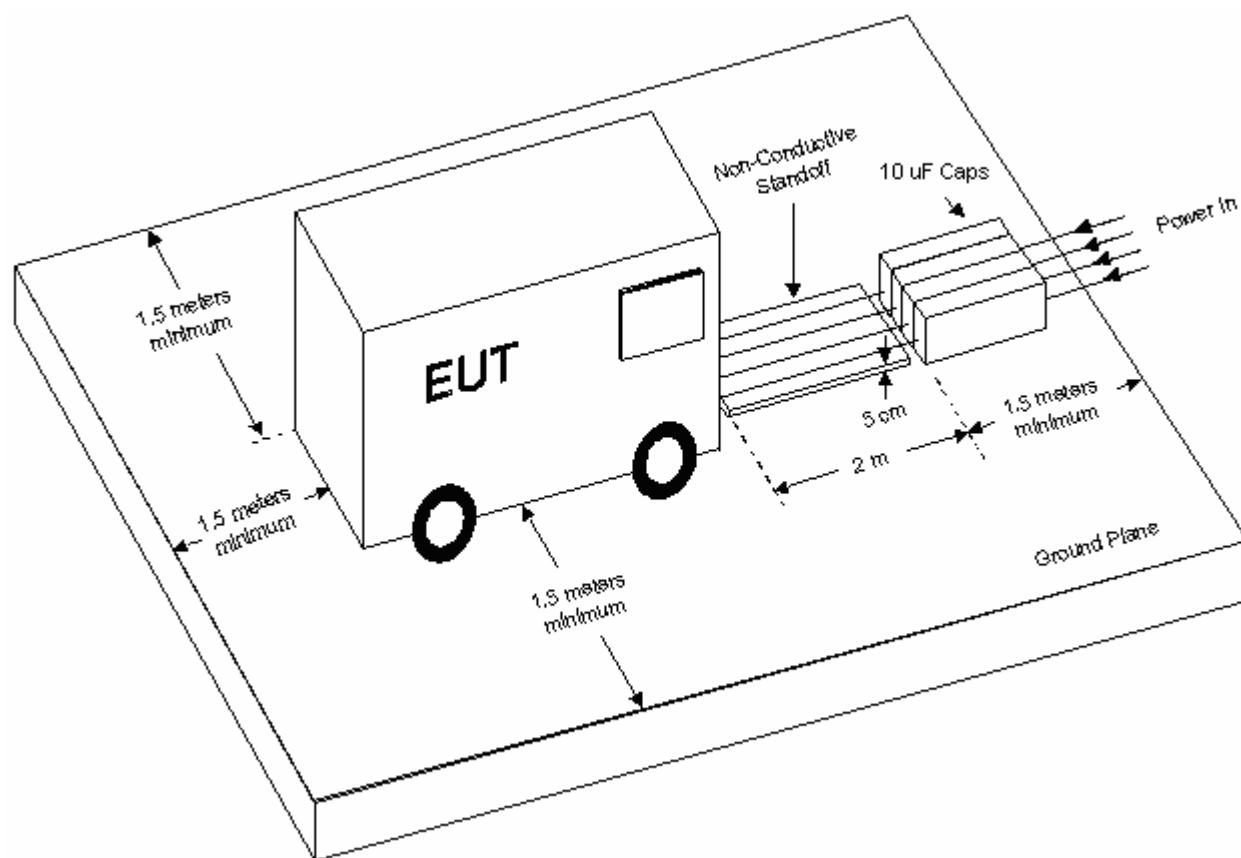


FIGURE 6. Test setup for free standing EUT.

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6. DETAILED REQUIREMENTS

6.1 General.

This section specifies detailed emissions and susceptibility requirements and the associated test procedures. Table VII is a list of the specific requirements established by SSP30237 and SSP30238 identified by requirement number and title. General test procedures are included in this section. Specific test procedures are implemented by the approved customer-prepared EMITP. All results of tests performed to demonstrate compliance with the requirements are to be documented in both the customer-prepared and the METF-prepared EMITR and forwarded to the designated authority for evaluation prior to acceptance of the equipment or subsystem.

6.1.1 Units of frequency domain measurements.

All frequency domain limits are expressed in terms of equivalent Root Mean Square (RMS) value of a sine wave as would be indicated by the output of a measurement receiver using peak envelope detection (see 5.3.10.1).

TABLE V. Emission and susceptibility requirements.

Subtest	Section in this procedure	Description
CE01	6.3	Conducted Emissions, Direct current power leads, 30 Hz to 15 kHz
CE03	6.4	Conducted Emissions, Direct current power leads, 15 kHz to 50 MHz
CE07	6.5	Conducted Emissions, Direct current power leads, spikes, time domain
CS01	6.6	Conducted Susceptibility, Direct current power leads, 30 Hz to 50 kHz
CS02	6.7	Conducted Susceptibility, Direct current power leads, 50 kHz to 50 MHz
CS06	6.8	Conducted Susceptibility, Spikes, power leads
RE02	6.9	Radiated Emissions, Electric Field, 14 kHz to 20 GHz (narrowband)
RS02	6.10	Radiated Susceptibility, Magnetic induction field
RS03	6.11	Radiated Susceptibility, Electric Field, 14 kHz to 20 GHz

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6.2 Tests applicable to this EUT and pass/fail status.

The tests applicable to this EUT are shown in Table VIII. The overall test results are shown in the pass/fail column. The detailed test results are contained in the EUT test run log and the test summary found in Section 1 of the METF test report. The two criteria pass or fail are assigned to emissions testing, where a defined limit line determines whether the EUT passes or fails. The two criteria pass or effects are assigned to susceptibility testing, where the EUT owner must determine whether a particular effect observed during a susceptibility test would affect mission performance or not.

TABLE VI. EUT Tests performed and test results.

Subtest	Applicable to this EUT	Section in this procedure	Pass/Fail/Effect
CE01		6.3	
CE03		6.4	
CE07		6.5	
CS01		6.6	
CS02		6.7	
CS06		6.8	
RE02		6.9	
RS02		6.10	
RS03		6.11	

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6.3 CE01, conducted emissions, direct current power, low frequency, 30 Hz to 15 kHz.

6.3.1 CE01 applicability.

SSP30237 states that CE01 is applicable only for narrowband conducted emissions in the frequency range between 30 Hz and 15 kHz on direct current (dc) leads which obtain power from or provide power to other equipment, distribution panels, or subsystems.

6.3.2 CE01 limits*.

SSP30237 states that electromagnetic emissions shall not appear on dc leads in excess of the values in Table CE01-1. The emission limit in Table CE01-1 is for equipment drawing one amp or less. For equipment drawing more than one amp, the limit in decibels (dB) as shown in Table CE01-1 shall be raised by 20 times log I, where I equals the total dc current used by the equipment under test. *** NOTE: The emissions shall be measured with an effective bandwidth not exceeding 100Hz.**

Table CE01-1. CE01 Emission Limit.

Frequency	Emission Limit
30 Hz to 200 Hz	110 dB above 1 microampere
200 Hz to 15 kHz	Decreasing log linearly with increasing frequency from 110 to 74 dB above 1 microampere

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6.3.3 CE01 test procedure.

6.3.3.1 CE01 Purpose.

SSP30238 states that the CE01 test procedure is used to verify that electromagnetic emissions from the EUT do not exceed the specified requirements for power input leads, including returns.

6.3.3.2 CE01 Test equipment.

The test equipment will be as follows:

Table CE01-2. METF CE01 Equipment.

Item	METF Equipment
Measurement receiver	Rohde & Schwarz ESI measurement receiver, 20Hz-26.5GHz, or equivalent
Data recording device	Personal computer functioning as data recording device
Signal Generator	Agilent 33220A, 0.1mHz-15MHz, or equivalent
Current Probe	Electro-metrics PCL-10, or equivalent
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent
Test Software	Rohde & Schwarz ES-K1, or equivalent

6.3.3.3 CE01 Setup.

The test setup shall be as follows:

- Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and paragraph 5.5
- Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- Take digital photographs of the CE01 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test. Take photos of the measurement system check as well as the test configuration for each power lead under test.

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d. Calibration.

- (1) Configure the test setup for the measurement system check as shown in Figure CE01-1.
- (2) Connect the 50 Ohm load directly to the calibration fixture.
- (3) Connect the signal generator to the calibration fixture using low loss RF cables (NOT RG-58 or RG-223) .
- (4) Connect the measurement receiver to the CE01 current probe using the actual low-loss coaxial cables that will be used to make the CE01 EUT measurement.
- (5) Record any deviation from the standard CE01 setup on CE01 deviation page(s) as needed.

e. EUT testing.

- (1) Configure the test setup for compliance testing of the EUT as shown in Figure CE01-2.
- (2) Place the current probe around the lead under test at the METF feed-through capacitor/power switch end of the EUT power cable. Connect the Rhode & Schwarz measurement receiver to the current probe using the same low-loss RF cables used for the calibration measurement.
- (3) Record any deviation from the standard CE01 setup on CE01 deviation page(s) as needed.

6.3.3.4 CE01 Procedures.

The test procedures shall be as follows:

- a. Calibration. Perform the measurement system check using the measurement system check setup of Figure CE01-1.
 - (1) Turn on the measurement equipment and allow a sufficient time for stabilization.
 - (2) Ensure that the appropriate correction factors for the current probe and low-loss measurement cables are entered in the Rhode and Schwarz CE01 scan table.
 - (3) Calculate the EUT CE01 limit at 50 Hz, 1 kHz, 10 kHz, and 15 kHz. For equipment drawing more than one amp, the limit in decibels (dB) as shown in Table CE01-1 shall be raised by 20 times log I, where I equals the total dc current used by the equipment under test.
 - (4) Calculate the signal generator drive level needed to generate a current that is 6dB below the limit at 50 Hz, 1 kHz, 10 kHz, and 15 kHz in the 50 Ohm calibration test fixture. The drive level = (EUT CE01 limit in dBuA – 6dB) – 73. This is calculated automatically using the METF CE01 measurement system spreadsheet (a sample is shown in Figure CE01-3) on the METF computer workstation. Note

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that the maximum current attainable from the standard signal generator is 96.98 dBuA. This level is sufficient to demonstrate measurement system operability, even though it is greater than 6 dB below the limit.

- (5) Apply the calculated signal generator drive levels that are 6 dB below the limit at 50 Hz, 1 kHz, 10 kHz and 15 kHz to the calibration test fixture.
 - (6) Scan the measurement receiver for each frequency in the same manner as a normal data scan, using the bandwidths and measurement times in Table CE01-1. Pause the EMI receiver control software at appropriate points to enable changing the signal generator frequency and amplitude. Verify that the measurement receiver indicates a level within ± 3 dB of the injected level.
 - (7) Record the signal injection level, measured level, and any attenuation used on the signal generator output in the METF CE01 measurement system spreadsheet on the METF computer workstation.
 - (8) If readings are obtained which deviate by more than ± 3 dB, locate the source of the error and correct the deficiency prior to proceeding with the testing.
 - (9) Record any deviations from the standard CE01 calibration procedure on CE01 deviation page(s) as needed.
- b. EUT testing. Perform emission data scans using the measurement setup of Figure CE01-2.
- (1) Turn on the EUT and allow a sufficient time for stabilization.
 - (2) Select an appropriate lead for testing. Place the current probe around the lead under test, ensuring that the current probe is completely closed.
 - (3) Scan the measurement receiver over the applicable frequency range, using the bandwidths and minimum measurement times in Table CE01-1.
 - (4) Repeat steps (2) and (3) above for each power lead.
 - (5) Record any deviations from the standard CE01 EUT test procedure on CE01 deviation page(s) as needed.

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6.3.3.5 CE01 Data presentation.

Data presentation shall be as follows:

- Continuously and automatically plot amplitude versus frequency profiles on X-Y axis outputs. Manually gathered data is not acceptable except for plot verification. Emissions greater than 20 dB below the specified limit shall be plotted. In cases where the noise floor and ambient are not 20 dB below the limit, only those emissions above the noise floor/ambient are required to be recorded.
- Display the applicable limit on each plot.
- Provide a minimum frequency resolution of 1% or twice the measurement receiver bandwidth, whichever is less stringent, and a minimum amplitude resolution of 1 dB for each plot.
- Provide plots for both the measurement system check and measurement portions of the procedure.
- Include the completed METF CE01 measurement system spreadsheet with the test data.
- Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.

Table CE01-1. Bandwidth and measurement time.

Frequency Range	6 dB Bandwidth	Dwell Time	Minimum Measurement Time Analog Measurement Receiver
30 Hz - 1 kHz	10 Hz	0.15 sec	0.015 sec/Hz
1 kHz - 10 kHz	100 Hz	0.015 sec	0.15 sec/kHz
10 kHz - 15 kHz	100 Hz	0.015 sec	0.015 sec/kHz

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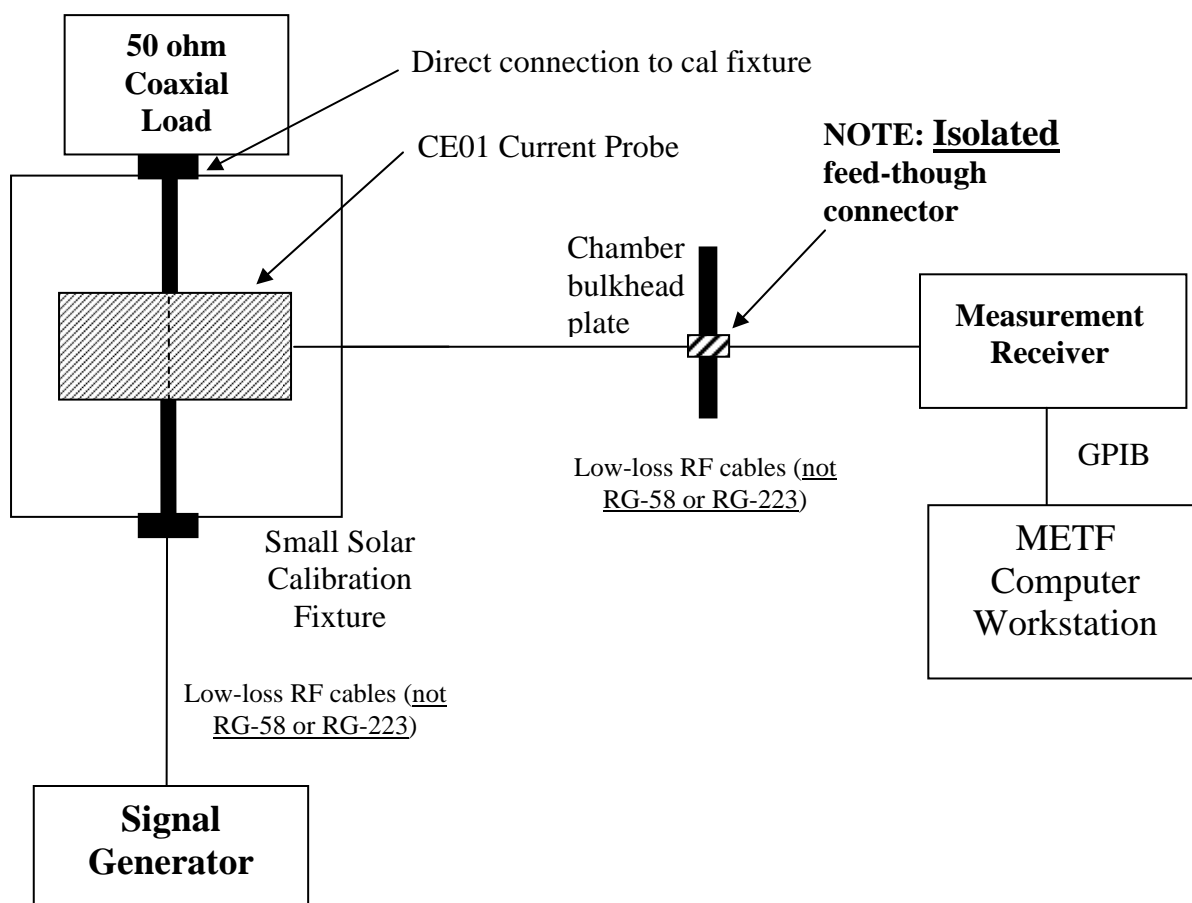


FIGURE CE01-1. Measurement system check setup.

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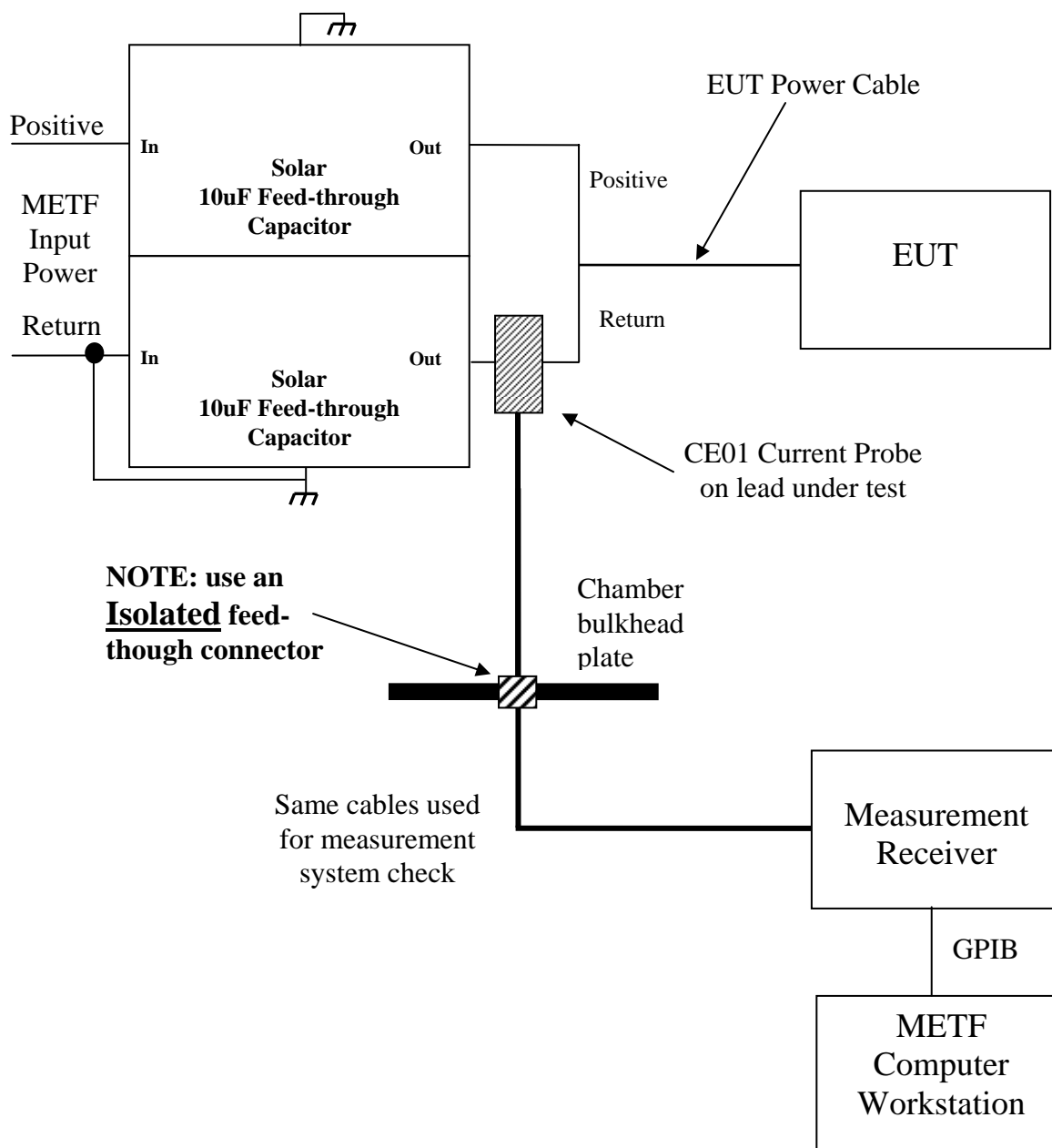


FIGURE CE01-2. Measurement setup.

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SSP30237 CE01 Inputs for System Checkout

EUT: Sample

Date: 5/1/06

Spec: SSP30237 (ISS)

Max Current draw: 1A

Scaling factor: 0dB

Frequency (kHz)	Spec Amplitude (dBμA)	Target Amplitude (dBμA)*	Input Level (dBm)	Measured Level (dBμA)	Delta	Signal Gen
0.05	110	96.98	23.98	96.97	0.01	33220A
1	96.58	90.58	17.58	90.3	0.28	33220A
10	77.38	71.38	-1.62	70.85	0.53	33220A
15	74	68	-5	68.12	-0.12	33220A

* 96.98 dBuA (23.98dBm) is max drive level for 33220A sig gen

FIGURE CE01-3. Sample METF CE01 Measurement System Spreadsheet.

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6.4 CE03, conducted emissions, direct current power, 15 kHz to 50 MHz.

6.4.1 CE03 applicability.

SSP30237 states that CE03 is applicable only for narrowband conducted emissions in the frequency range between 15 kHz and 50 MHz on direct current (dc) leads which obtain power from other sources or provide power to other equipment, distribution panels, or subsystems.

6.4.2 CE03 limits.

SSP30237 states that electromagnetic emissions shall not appear on dc leads in excess of the values in Table CE03-1. The emission limit in Table CE03-1 is for equipment drawing one amp or less. For equipment drawing more than one amp, the limit in decibels (dB) as shown in Table CE03-1 shall be raised by 20 times log I, where I equals the total dc current used by the equipment under test.

Table CE03-1. CE03 Emission Limit.

Frequency	Emission Limit
15 kHz to 500 kHz	Decreasing log linearly with increasing frequency from 74 dB to 45 dB above 1 microampere
500 kHz to 50 MHz	45 dB above 1 microampere

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6.4.3 CE03 test procedure.

6.4.3.1 CE03 Purpose.

SSP30238 states that the CE03 test procedure is used to verify that electromagnetic emissions from the EUT do not exceed the specified requirements for power input leads, including returns.

6.4.3.2 CE03 Test equipment.

The test equipment will be as follows:

Table CE03-2. METF CE03 Equipment.

Item	METF Equipment
Measurement receiver	Rohde & Schwarz ESI measurement receiver, 20Hz-26.5GHz, or equivalent
Data recording device	Personal computer functioning as data recording device
Low frequency signal generator	Agilent 33220A, 0.1mHz-15MHz, or equivalent
High frequency signal generator	Agilent E8257C, or equivalent
Current Probe	Empire Devices CP-105, or equivalent
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent
Test Software	Rohde & Schwarz ES-K1, or equivalent

6.4.3.3 CE03 Setup.

The test setup shall be as follows:

- a. Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and paragraph 5.5
- b. Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- c. Take digital photographs of the CE03 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test. Take photos of the measurement system check as well as the test configuration for each power lead under test.
- d. Calibration.
 - (1) Configure the test setup for the measurement system check as shown in Figure CE03-1.
 - (2) Connect the 50 Ohm load directly to the calibration fixture.

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- (3) Connect the signal generator to the calibration fixture using a low-loss RF cable (not RG-58 or RG-223) .
 - (4) Connect the measurement receiver to the CE03 current probe using the actual low-loss coaxial cables that will be used to make the CE03 EUT measurement.
 - (5) Record any deviation from the standard CE03 setup on CE03 deviation page(s) as needed.
- e. EUT testing.
- (1) Configure the test setup for compliance testing of the EUT as shown in Figure CE03-2.
 - (2) Place the current probe around the lead under test at the METF feed-through capacitor/power switch end of the EUT power cable. Connect the Rhode & Schwarz measurement receiver to the current probe using the same low-loss RF cables used for the calibration measurement.
 - (3) Record any deviation from the standard CE03 setup on CE03 deviation page(s) as needed.

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6.4.3.4 CE03 Procedures.

The test procedures shall be as follows:

- a. Calibration. Perform the measurement system check using the measurement system check setup of Figure CE03-1.
 - (1) Turn on the measurement equipment and allow a sufficient time for stabilization.
 - (2) Ensure that the appropriate correction factors for the current probe and low-loss measurement cables are entered in the Rhode and Schwarz CE03 scan table.
 - (3) Calculate the EUT CE03 limit at 150 kHz, 30 MHz, and 50 MHz. For equipment drawing more than one amp, the limit in decibels (dB) as shown in Table CE03-1 shall be raised by 20 times log I, where I equals the total dc current used by the equipment under test.
 - (4) Calculate the signal generator drive level needed to generate a current that is 6dB below the limit at 150 kHz, 30 MHz, and 50 MHz in the 50 Ohm calibration test fixture. The drive level = (EUT CE03 limit in dBuA – 6dB) – 73. This is calculated automatically using the METF CE03 measurement system spreadsheet (shown in Figure CE03-3) on the computer workstation.
 - (4) Apply the calculated signal generator drive levels that are 6 dB below the limit at 150 kHz, 30 MHz, and 50 MHz to the calibration test fixture.
 - (5) Scan the measurement receiver for each frequency in the same manner as a normal data scan, using the bandwidths and measurement times in Table CE01-1. Pause the EMI receiver control software at appropriate points to enable changing the signal generator frequency and amplitude. Verify that the measurement receiver indicates a level within ± 3 dB of the injected level.
 - (6) Record the signal injection level, measured level, and any attenuation used on the signal generator output in the METF CE01 measurement system spreadsheet on the METF computer workstation.
 - (7) If readings are obtained which deviate by more than ± 3 dB, locate the source of the error and correct the deficiency prior to proceeding with the testing.
 - (8) Record any deviations from the standard CE01 calibration procedure on CE01 deviation page(s) as needed.
- b. EUT testing. Perform emission data scans using the measurement setup of Figure CE01-2.
 - (1) Turn on the EUT and allow a sufficient time for stabilization.
 - (2) Select an appropriate lead for testing. Place the current probe around the lead under test, ensuring that the current probe is completely closed.

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- (3) Scan the measurement receiver over the applicable frequency range, using the bandwidths and minimum measurement times in Table III.
- (4) Repeat steps (2) and (3) above for each power lead.
- (5) Record any deviations from the standard CE03 EUT test procedure on CE03 deviation page(s) as needed.

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6.4.3.5 CE03 Data presentation.

Data presentation shall be as follows:

- a. Continuously and automatically plot amplitude versus frequency profiles on X-Y axis outputs. Manually gathered data is not acceptable except for plot verification. Emissions greater than 20 dB below the specified limit shall be plotted. In cases where the noise floor and ambient are not 20 dB below the limit, only those emissions above the noise floor/ambient are required to be recorded.
- b. Display the applicable limit on each plot.
- c. Provide a minimum frequency resolution of 1% or twice the measurement receiver bandwidth, whichever is less stringent, and a minimum amplitude resolution of 1 dB for each plot.
- d. Provide plots for both the measurement system check and measurement portions of the procedure.
- e. Include the completed METF CE03 measurement system spreadsheet with the test data.
- f. Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.

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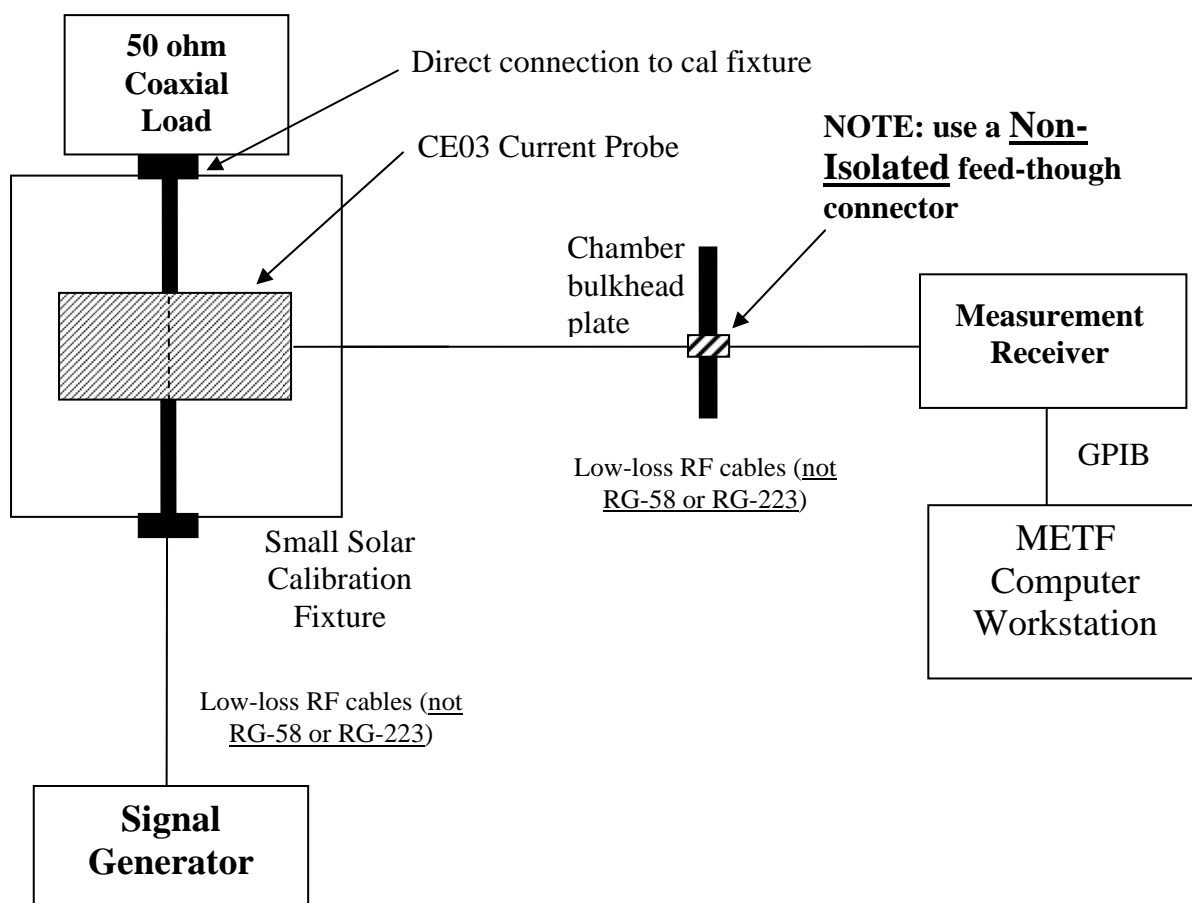


FIGURE CE03-1. Measurement system check setup.

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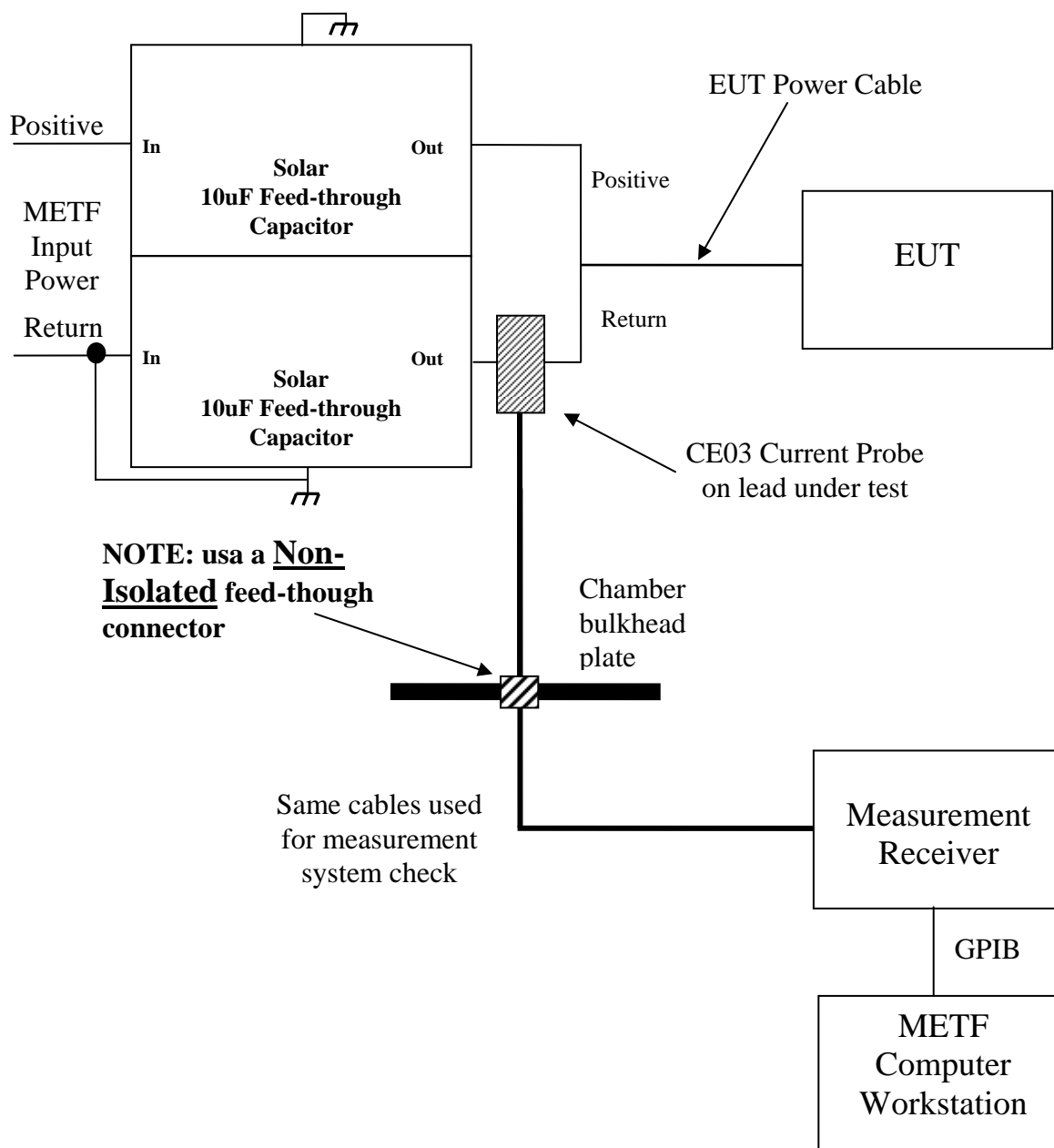


FIGURE CE03-2. Measurement setup.

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SSP30237 CE03 Inputs for System Checkout

EUT: Sample
Date: 1-May-06
Spec: SSP30237 (ISS)

Max Current draw: 1A

Scaling factor: 0dB

Frequency (MHz)	Spec Amplitude (dBμA)	Target Amplitude (dBμA)	Input Level (dBm)	Measured Level (dBμA)	Delta	Signal Gen
0.15	74	68	-5	67.83	0.17	33220A
30	45	39	-34	39.31	-0.31	8257
50	45	39	-34	39.12	-0.12	8257

FIGURE CE03-3. Sample METF CE03 Measurement System Spreadsheet.

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6.5 CE07, conducted emissions, direct current power, spikes, time domain.

6.5.1 CE07 applicability.

SSP30237 states that CE07 is applicable for dc input power leads.

6.5.2 CE07 limits.

SSP30237 states that CE07 on and off and mode switching transients shall not exceed the envelope defined by the values in Table CE07-1. Repetitive on and off and mode switching transients shall not occur more frequently than every 100 milliseconds.

Table CE07-1. CE07 mode switching transients envelope.

Time (microseconds)	Percentage of nominal line voltage
0.1 to 10	± 50 percent
10 to 50	Decreasing log linearly with increasing time from ± 50 percent to ± 20 percent
50 to 1000	Decreasing log linearly with increasing time from ± 20 percent to ± 5 percent, or ± 6 volts, whichever is greater
1000 to 10,000	± 6 percent or ± 0.5 volts, whichever is greater
10,000 to 100,000	± 5 percent or ± 0.5 volts, whichever is greater

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6.5.3 CE07 test procedure.

6.5.3.1 CE07 Purpose.

SSP30238 states that the purpose of the CE07 test method is to measure in the time domain, the load induced effect on dc power quality caused by cycling the EUT power and operating modes. This method is applicable for measuring time domain spikes occurring when loads are energized in a discrete manner from secondary power (example: remote power controller). Measurements shall be made line to line. The requirement for turn-off transients is applicable only when the power switch is contained within the EUT (as opposed to a remotely located power switch or circuit breaker).

6.5.3.2 CE07 Test equipment.

The test equipment will be as follows:

Table CE07-2. METF CE07 Equipment.

Item	METF Equipment
Digital oscilloscope, with isolated channels	THS720A, 100MHz, or equivalent
Data recording device	Personal computer functioning as data recording device
Line Impedance Simulation Network (LISN)	Solar Type 9238-10-TS-50, 150Vdc/50A, or equivalent
Solid State switch	METF Field Effect Transistor (FET) switch, Remote Power Control Module (RPCM) emulator, or equivalent
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent
Test Software	METF Automated EMI Test Application (AETA) New TT01, or equivalent

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6.5.3.3 CE07 Setup.

The test setup shall be as follows:

- a. Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and paragraph 5.5
- b. Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- c. Take digital photographs of the CE07 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test.
- d. Calibration.
 - (1) Configure the test setup for the oscilloscope measurement system check as shown in Figure CE07-2. Connect the oscilloscope probe and ground clip lead to the oscilloscope probe compensation output tabs.
 - (2) If using the RPCM emulator, also configure the test setup for the RPCM emulator measurement system check as shown in Figure CE07-2. Connect the oscilloscope probe across the outputs of the RPCM emulator.
 - (3) Record any deviation from the standard CE07 setup on CE07 deviation page(s) as needed.
- e. EUT testing.
 - (1) Configure the test setup for compliance testing of the EUT as shown in Figure CE07-3. Use the appropriate configuration for either the FET switch or RPCM emulator. Use the ISS LISN with the required characteristics in Figure CE07-1.
 - (2) Connect the oscilloscope probe to the LISN output.
 - (3) Record any deviation from the standard CE07 setup on CE07 deviation page(s) as needed.

6.5.3.4 CE07 Procedures.

The test procedures shall be as follows:

- a. Calibration. Perform the measurement system check using the measurement system check setup of Figure CE07-2.
 - (1) Turn on the measurement equipment and allow a sufficient time for stabilization.
 - (2) Configure the oscilloscope to capture a turn on transient.
 - (3) Perform the following oscilloscope measurement system check. With the scope lead ground clip attached to the ground tab of the probe compensation output on

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the scope, touch the scope probe tip to the probe compensation tab on the scope. Ensure that the scope triggers.

- (4) Import the captured waveform into the computer.
- (5) Compare the captured waveform to the known scope compensation output waveform to verify the waveform amplitude and period.
- (6) If the captured waveform is not correct, locate the source of the error and correct the deficiency prior to proceeding with the testing.
- (7) If using the RPCM emulator to power the EUT, also verify its functionality using the following measurement system check. Connect the RPCM emulator in the test setup, but not connected to the EUT as shown in Figure CE07-2.. With the RPCM outputs unloaded, turn on the RPCM.
- (8) Import the captured waveform into the computer.
- (9) Compare the captured waveform to the RPCM required turn on waveform: the 10% to 90% turn on time is 1-5 milliseconds.
- (10) If the captured waveform is not correct, locate the source of the error and correct the deficiency prior to proceeding with the testing.
- (11) Record any deviations from the standard CE07 calibration procedure on CE07 deviation page(s) as needed.

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- b. EUT testing. Perform transient data capture using the measurement setup of Figure CE07-3.
- (1) With the FET switch open or the RPCM emulator off, apply input power to the LISN. Verify that the correct dc voltage is present at the LISN output.
 - (2) Configure the oscilloscope for a turn on transient (negative trigger slope). The amplitude and time scales will have to be determined empirically during the test. Select reasonable values for the initial turn on transient which will then be refined based on the first measured transient.
 - (3) Measure and record the turn-on transient as the FET switch is closed or the RPCM emulator is turned on.
 - (4) Configure the oscilloscope for a turn off transient (positive trigger slope). The amplitude and time scales will have to be determined empirically during the test. Select reasonable values for the initial turn off transient which will then be refined based on the first measured transient. Measure and record the turn-on transient as the FET switch is opened or the RPCM emulator is turned off.
 - (5) Measure and record the turn-off transient as the FET switch is opened or the RPCM emulator is turned off.
 - (6) Repeat steps (2) through (5) above until the complete turn on and turn off transient waveforms are captured. Between measurements, bleed the EUT input capacitance with a resistor connected across the EUT power leads with the FET switch open. Wait at least one minute after the EUT has been de-energized before measuring another turn on transient. Remove the resistor from the EUT power leads before closing the FET switch.
 - (7) After the turn on and turn off transients have been captured, measure all applicable EUT mode switching transients. These mode switch transients are typically measured after the EUT has been powered by the FET switch and achieved a steady state condition. The EUT is switched between modes via EUT software commands. Measure mode switch turn on transients using a negative oscilloscope trigger slope and mode switch turn off transients using a positive oscilloscope trigger slope.
 - (5) Record any deviations from the standard CE07 EUT test procedure on CE07 deviation page(s) as needed.

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6.5.3.5 CE07 Data presentation.

Data presentation shall be as follows:

- a. Print a graph of the oscilloscope waveform capture for each recorded transient, including all axis and unit labels necessary for proper interpretation. Label each plot with the transient being measured and the EUT equipment state prior to the transient event.
- b. Display the applicable limit on each plot.
- c. Provide plots for both the measurement system check and measurement portions of the procedure.
- d. Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.

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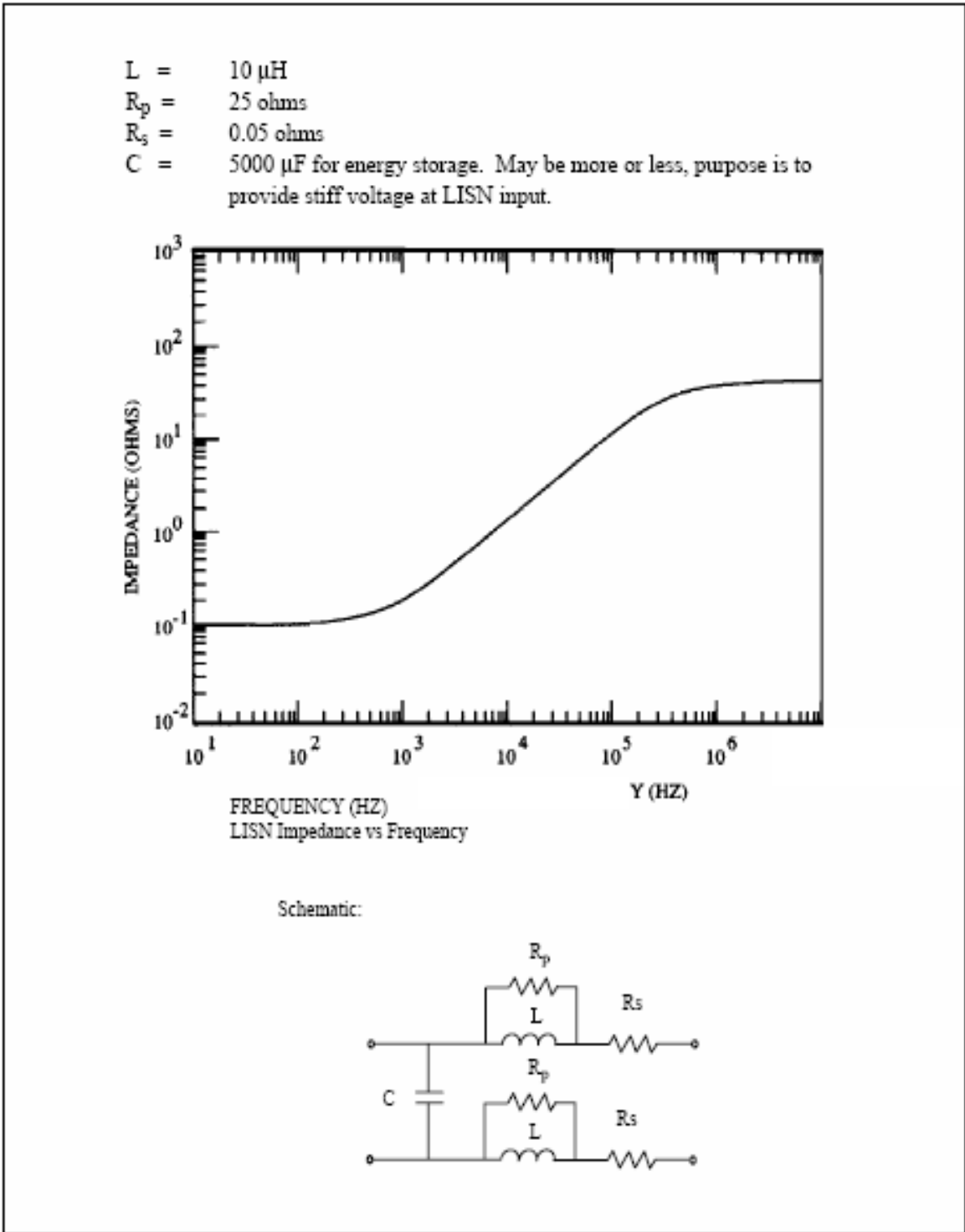
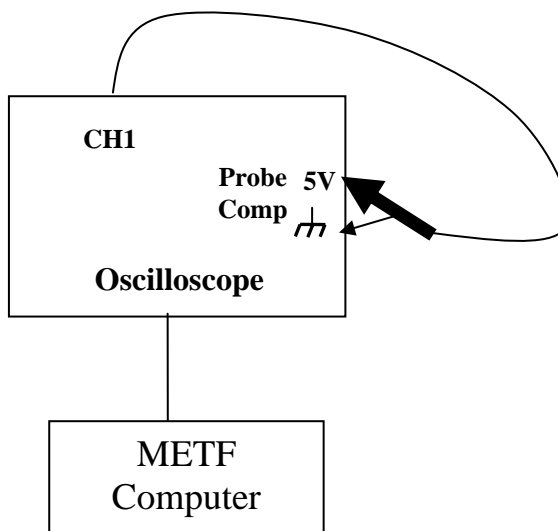


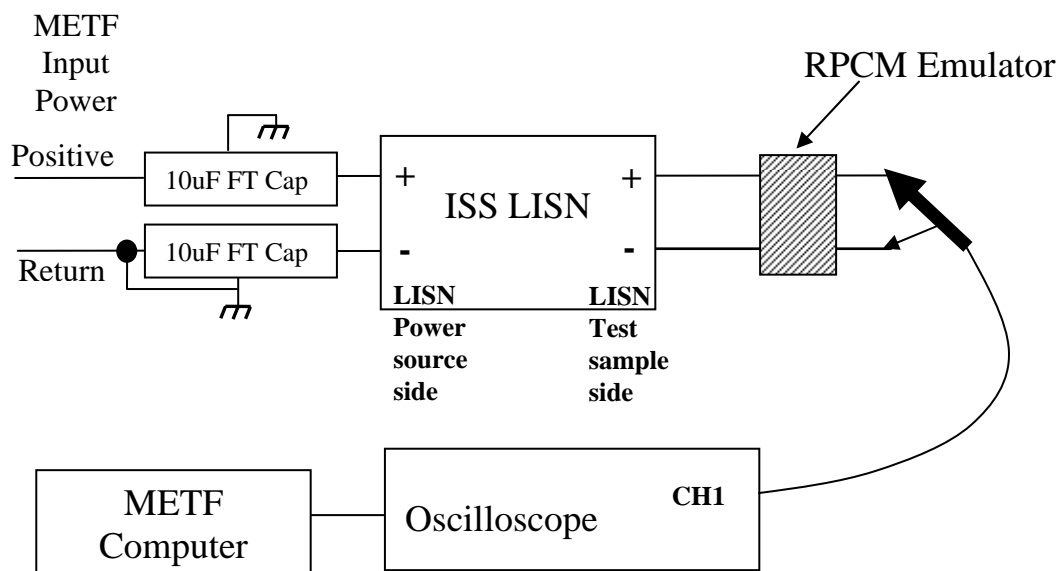
FIGURE CE07-1. LISN for CE07 measurements.

CE07

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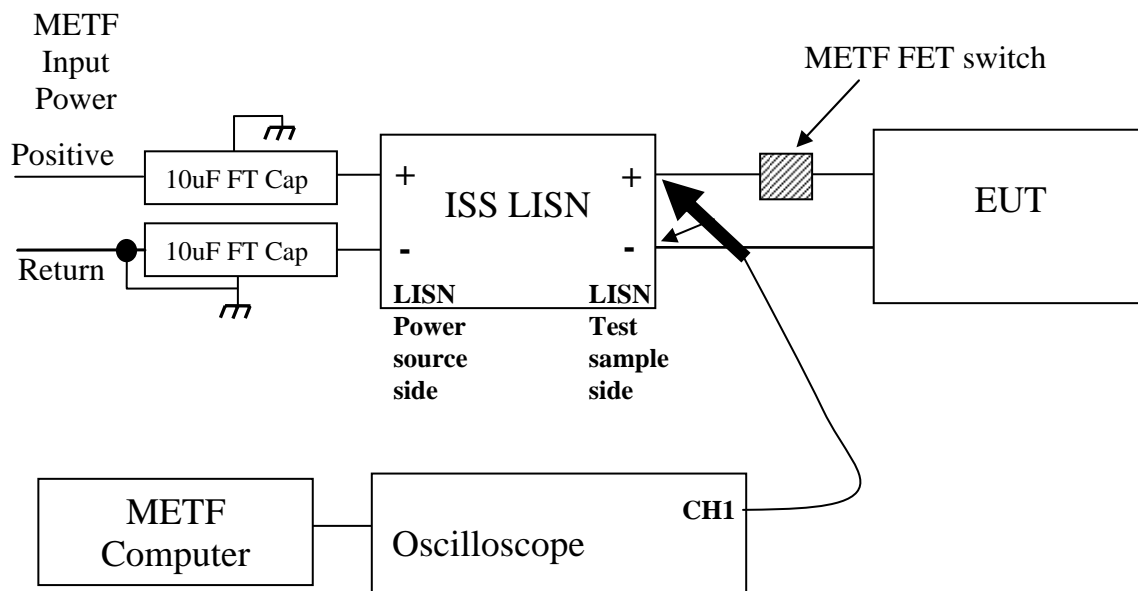
Measurement system check for oscilloscope setup



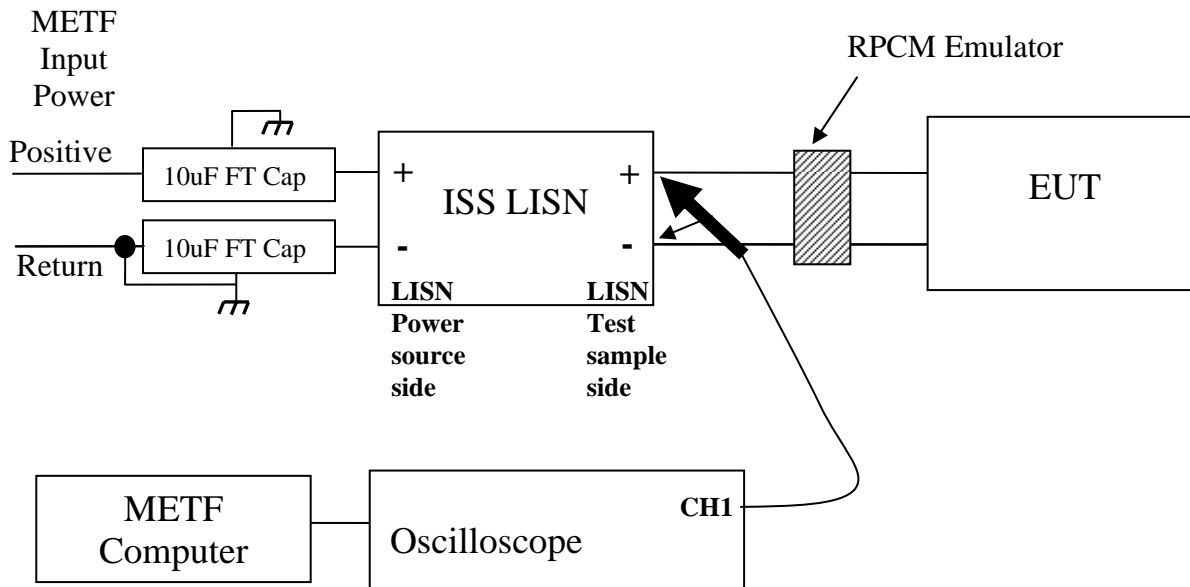
Measurement system check for RPCM emulator

FIGURE CE07-2. Measurement system check setup.

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Measurement setup using METF FET switch



Measurement setup using RPCM Emulator

FIGURE CE07-3. Measurement setup.

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6.6 CS01, conducted susceptibility, power leads, 30 Hz to 50 kHz.

6.6.1 CS101 applicability.

SSP30237 states that this requirement is applicable for determining susceptibility of equipment and subsystems to electrical energy appearing on dc power leads, including returns.

6.6.2 CS01 limit.

SSP30237 states that the EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to electromagnetic energy injected onto its power leads less than or equal to the values shown in Table CS01-1. The requirement is also met when the audio power specified in SSP30238, adjusted to dissipate 50 Watts in a 0.5 Ohm load, cannot develop the required voltage at the EUT power input terminals and the EUT is not susceptible to the output of the signal source.

Table CS01-1. CS01 Electromagnetic Energy Injection.

Frequency	Emission Limit
30 Hz to 2 kHz	5 Volts root mean square (Vrms) or 10 percent of the supply voltage (E1), whichever is less
2 kHz to 50 kHz	Decreasing log linearly with increasing frequency from 5 Vrms, or 10 percent E1 whichever is less, to either 1 Vrms or 1 percent of E1, whichever is less

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6.6.3 CS01 test procedure.

6.6.3.1 CS01 Purpose.

SSP30238 states that the CS01 test procedure is used to verify the ability of the EUT to withstand signals coupled onto input power leads.

6.6.3.2 CS01 Test equipment.

The test equipment will be as follows:

Table CS01-1. METF CS01 Equipment.

Item	METF Equipment
Signal generator	Agilent 33220A, 0.1mHz-15MHz, or equivalent
Power amplifier	Techron 7521 power amplifier, 20Hz-25kHz, 144W, or equivalent
Oscilloscope	Tektronix TDS5104B, 1GHz, or equivalent
Coupling transformer	Solar Type 6220-1A coupling transformer, 30Hz-250kHz, 50A dc
Capacitor, 10uF	Capacitor, 10uF
Resistor, 0.5 ohm	Dale RH-250 250W resistor, 0.5 ohm (two 1 ohm resistors in parallel) or equivalent
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent
Test Software	Total Integrated Laboratory Environment (TILE), or equivalent
Voltmeter	HP3458A digital voltmeter, or equivalent
Video monitoring camera	EMC Automation VC-04 video camera, controller, and monitor or equivalent

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6.6.3.3 CS01 Setup.

The test setup shall be as follows:

- a. Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and 5.5.
- b. Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- c. Take digital photographs of the CS01 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test. Take photographs of the calibration setup as well as the test configuration for each power lead under test.
- d. Calibration. Configure the test equipment in accordance with Figure CS01-1. Set up the oscilloscope, voltmeter and test software to monitor the voltage across the 0.5 ohm resistor.
- e. Trial run on calibration resistor. Configure the test equipment in accordance with Figure CS101-1. Set up the oscilloscope, voltmeter, and test software to monitor the voltage across the 0.5 ohm resistor.
- f. EUT testing. Configure the test equipment in accordance with Figure CS01-2.
- g. Record any deviations from the CS01 calibration or EUT test setup on CS01 deviation sheet(s) as needed.

6.6.3.4 CS01 Procedures.

The test procedures shall be as follows:

- a. Turn on the measurement equipment and allow sufficient time for stabilization.
- b. Calibration.
 - (1) Configure the EMI test software to set the signal generator to the lowest test frequency.
 - (2) Increase the applied signal until the oscilloscope and the digital multimeter indicate the voltage level corresponding to the maximum required power level specified for the limit. Verify the output waveform is sinusoidal on the oscilloscope. The digital multimeter is the primary injection loop monitor and the oscilloscope is only a secondary monitor.
 - (3) The test software will record the setting of the signal source for this power level.
 - (4) Scan the required frequency range for testing and record the signal source setting needed to maintain the required 50 Watt power level.

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- c. Trial run on calibration resistor to confirm test setup is correct, applied voltage level is correct, and waveform is sinusoidal.
 - (1) Configure the test software for a CS01 run with the same parameters as for a EUT run (amplitude, frequency step size, etc.)
 - (2) Perform a CS01 run on the calibration resistor. Closely monitor the oscilloscope screen, using the remote control camera, to ensure the correct voltage is applied at each frequency and that the waveform is sinusoidal. The digital multimeter is the primary injection loop monitor and the oscilloscope is only a secondary monitor.
 - (3) If the oscilloscope does not agree with the test software output, stop and determine the source of the problem. Correct the problem before continuing to EUT testing.
- d. EUT Testing.
 - (1) Turn on the EUT and allow sufficient time for stabilization.
 - (2) Configure the test software to set the signal generator to the lowest test frequency. Increase the signal level until the required voltage or power level is reached on the power lead. Note: Power is limited to the level calibrated in step 6.6.3.4b(2) above.
 - (3) While maintaining at least the required signal level, scan through the required frequency range at a rate no greater than specified in Table IV.
 - (4) Closely monitor the oscilloscope screen, using the remote control camera, to ensure that the CS01 voltage limit is not exceeded. If the voltage is exceeded at any frequency, immediately stop the test software and determine the source of the problem. The digital multimeter is the primary injection loop monitor and the oscilloscope is only a secondary monitor.
 - (5) Susceptibility evaluation.
 - (a) Monitor the EUT for degradation of performance.
 - (b) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3.
 - (5) Repeat steps 2 through 5 above for each power lead (positive and return), as required.

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6.6.3.5. CS01 Data presentation.

Data presentation shall be as follows:

- a. Provide graphical or tabular data showing the frequencies and amplitude from the calibration run.
- b. Provide graphical or tabular data showing the frequencies and amplitude from the trial run on the calibration resistor.
- c. Provide graphical or tabular data showing the frequencies and amplitudes at which the test was conducted for each lead.
- d. Provide data on any susceptibility thresholds and the associated frequencies that were determined for each power lead.
- e. Provide indications of compliance with the applicable requirements for the susceptibility evaluation specified in 5.4.8.3c for each lead.
- f. Record any deviations from the standard CS01 calibration or EUT test procedures on CS01 deviation sheet(s) as needed.
- g. Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.

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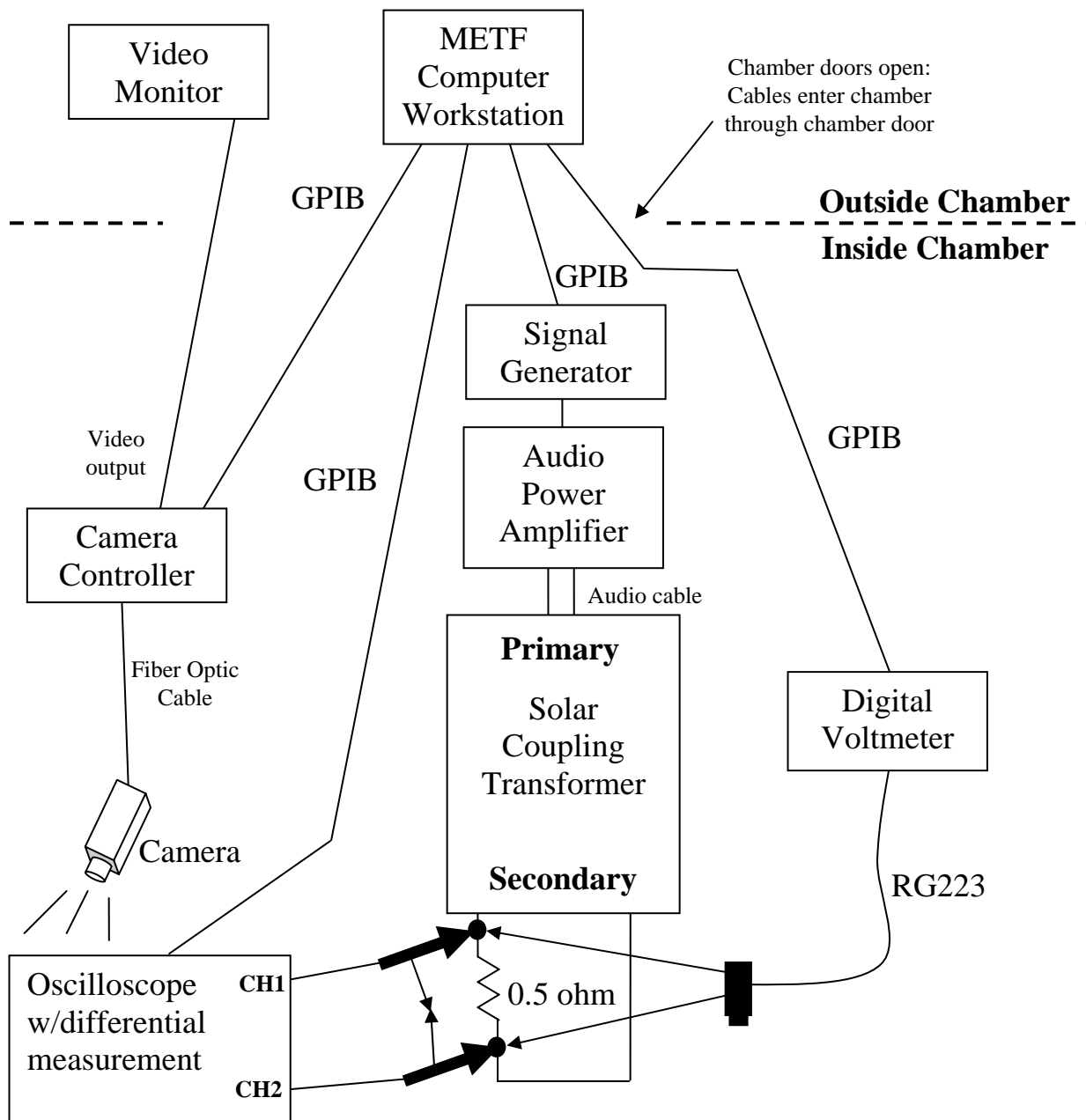


FIGURE CS01-1. CS01 Calibration.

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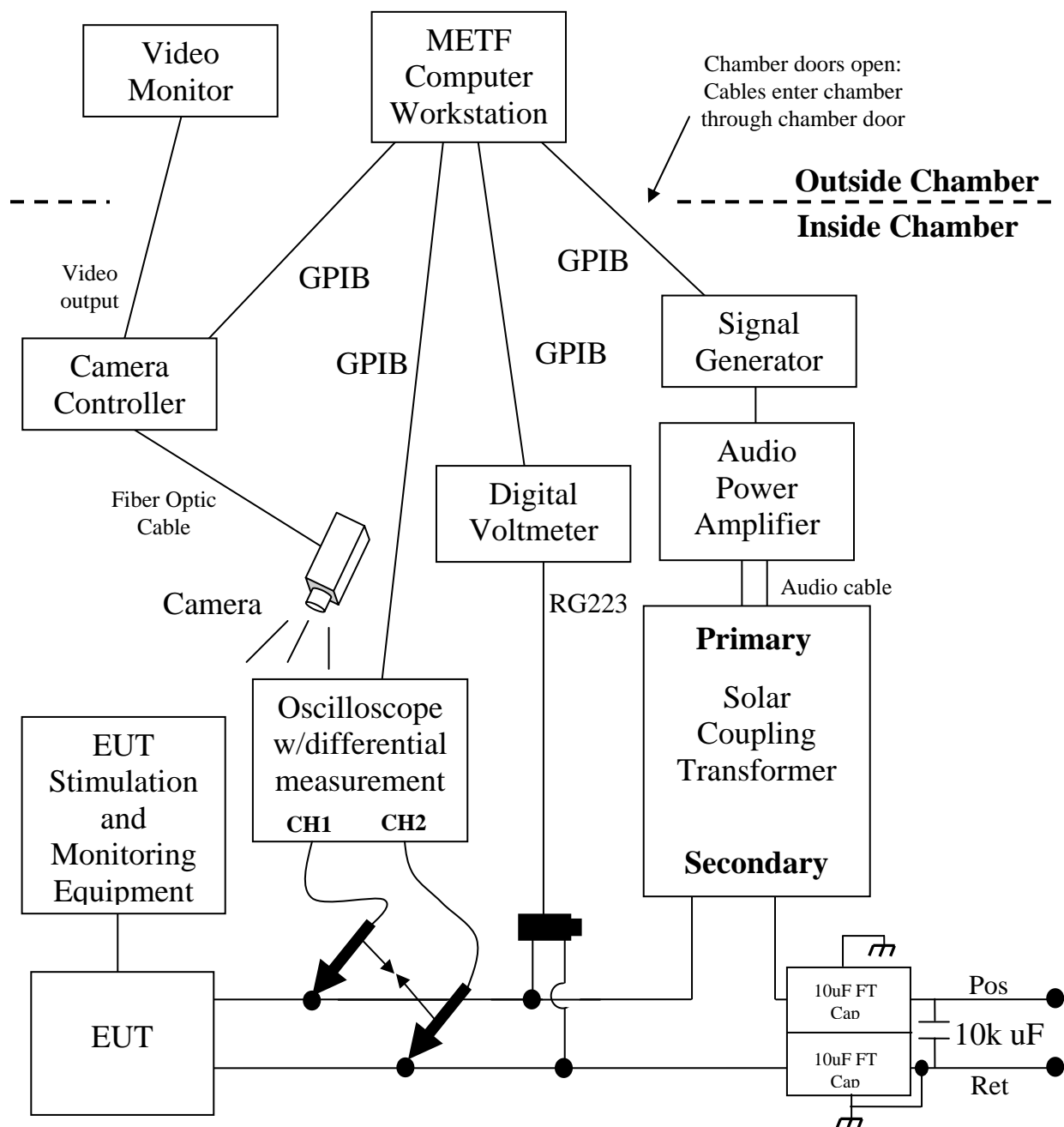


FIGURE CS01-2. CS01 Signal injection.

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6.7 CS02, conducted susceptibility, power leads, 50 kHz to 50 MHz.

6.7.1 CS02 applicability.

SSP30237 states that this requirement is applicable for determining susceptibility of equipment and subsystem dc power leads, including power returns, which are not grounded internally to the equipment or subsystem.

6.7.2 CS02 limit.

SSP30237 states that the EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to 1 Vrms from a 50 Ohm source. The test signal shall be applied to the equipment power line near the equipment input terminals. The requirement is also met when a 1 Watt source of 50 Ohms impedance cannot develop the required voltage at the EUT power input terminals and the EUT is not susceptible to the output of the signal source.

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6.7.3 CS02 test procedure.

6.7.3.1 CS02 Purpose.

SSP30238 states that the CS02 test procedure is used to determining susceptibility of equipment and subsystems to electrical energy appearing on dc power leads including power returns and which are not grounded internally to the equipment or subsystem.

6.7.3.2 CS02 Test equipment.

The test equipment will be as follows:

Table CS02-1. METF CS02 Equipment.

Item	METF Equipment
Low frequency signal generator	Agilent 33220A, 0.1mHz-15MHz, or equivalent
High frequency signal generator	Agilent E8257C, or equivalent
RF amplifier	Amplifier Research model 150A220, 10kHz-220MHz, 150W, or equivalent
Oscilloscope	Tektronix TDS5104B, 1GHz, or equivalent
Spectrum Analyzer	HP8566B, or equivalent
Coupling capacitor box	Solar Type 7415-3 RF Coupler and High Pass Filter, or equivalent
Line Impedance Simulation Network (LISN)	Solar Type 9238-10-TS-50, 150Vdc/50A, or equivalent
Resistor, 50 ohm	50 Ohm 2 Watt RF load, or equivalent
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent
Test Software	Total Integrated Laboratory Environment (TILE), or equivalent
Video monitoring camera	EMC Automation VC-04 video camera, controller, and monitor or equivalent

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6.7.3.3 CS02 Setup.

The test setup shall be as follows:

- a. Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and 5.5.
- b. Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- c. Take digital photographs of the CS02 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test. Take photos of the calibration configuration as well as the test configuration for each power lead under test.
- d. Calibration. Configure the test equipment in accordance with Figure CS02-1. Set up the oscilloscope and test software to monitor the voltage across the 50 ohm load.
- e. Trial run on 50 ohm load. Configure the test equipment in accordance with Figure CS02-1. Set up the oscilloscope and test software to monitor the voltage across the 50 ohm load.
- f. EUT testing. Configure the test equipment in accordance with Figure CS01-2.
- g. Record any deviations from the CS02 calibration or EUT test setup on CS02 deviation sheet(s) as needed.

6.7.3.4 CS02 Procedures.

The test procedures shall be as follows:

- a. Turn on the measurement equipment and allow sufficient time for stabilization.
- b. Calibration.
 - (1) Configure the EMI test software to set the signal generator to the lowest test frequency.
 - (2) Increase the applied signal until the oscilloscope indicates the voltage level corresponding to the maximum required power level specified for the limit. Verify the output waveform is sinusoidal on the oscilloscope.
 - (3) The test software will record the setting of the signal source for this power level.
 - (4) Scan the required frequency range for testing and record the signal source setting needed to maintain the required 1 Watt power level.

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- c. Trial run on 50 Ohm load to confirm the test setup is correct and the applied voltage level is correct.
 - (1) Configure the test software for a CS02 run with the same parameters as for a EUT run (amplitude, frequency step size, etc.)
 - (2) Perform a CS02 run on the 50 Ohm load. Closely monitor the oscilloscope screen, using the remote control camera, to ensure the correct voltage is applied at each frequency and that the waveform is sinusoidal.
 - (3) If any problems are encountered during the run on the 50 Ohm load, stop and determine the source of the problem. Correct the problem before continuing to EUT testing.
- d. EUT Testing.
 - (1) Turn on the EUT and allow sufficient time for stabilization.
 - (2) Configure the test software to set the signal generator to the lowest test frequency. Increase the signal level until the required voltage or power level is reached on the power lead. Note: Power is limited to the level calibrated in step 6.7.3.4b(2) above.
 - (3) While maintaining at least the required signal level, scan through the required frequency range at a rate no greater than specified in Table V.
 - (4) Closely monitor the injection level in the test software as well as the oscilloscope screen, using the remote control camera, to ensure that the CS02 voltage limit is not exceeded. If the voltage is exceeded at any frequency, immediately stop the test software and determine the source of the problem.
 - (5) Susceptibility evaluation.
 - (a) Monitor the EUT for degradation of performance.
 - (b) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3c and verify that it is above the limit.
 - (5) Repeat steps 2 through 5 above for each power lead (positive and return), as required.

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6.7.3.5. CS02 Data presentation.

Data presentation shall be as follows:

- a. Provide graphical or tabular data showing the frequencies and amplitude from the calibration run.
- b. Provide graphical or tabular data showing the frequencies and amplitude from the trial run on the calibration resistor.
- c. Provide graphical or tabular data showing the frequencies and amplitudes at which the test was conducted for each lead.
- d. Provide data on any susceptibility thresholds and the associated frequencies that were determined for each power lead.
- e. Provide indications of compliance with the applicable requirements for the susceptibility evaluation specified in 5.4.8.3c for each lead.
- f. Record any deviations from the standard CS02 calibration or EUT test procedures on CS02 deviation sheet(s) as needed.
- g. Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.

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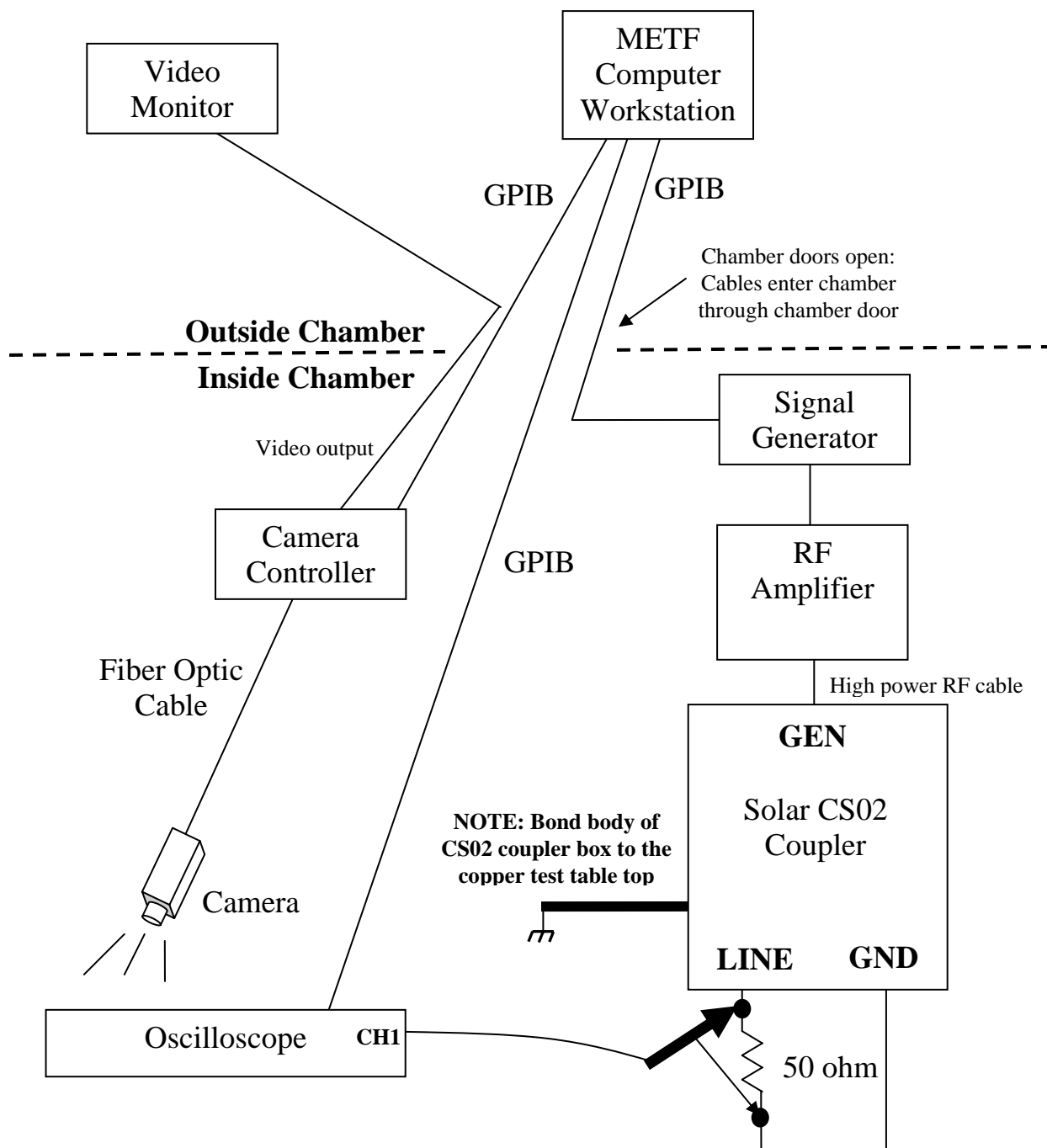


FIGURE CS02-1. CS02 Calibration.

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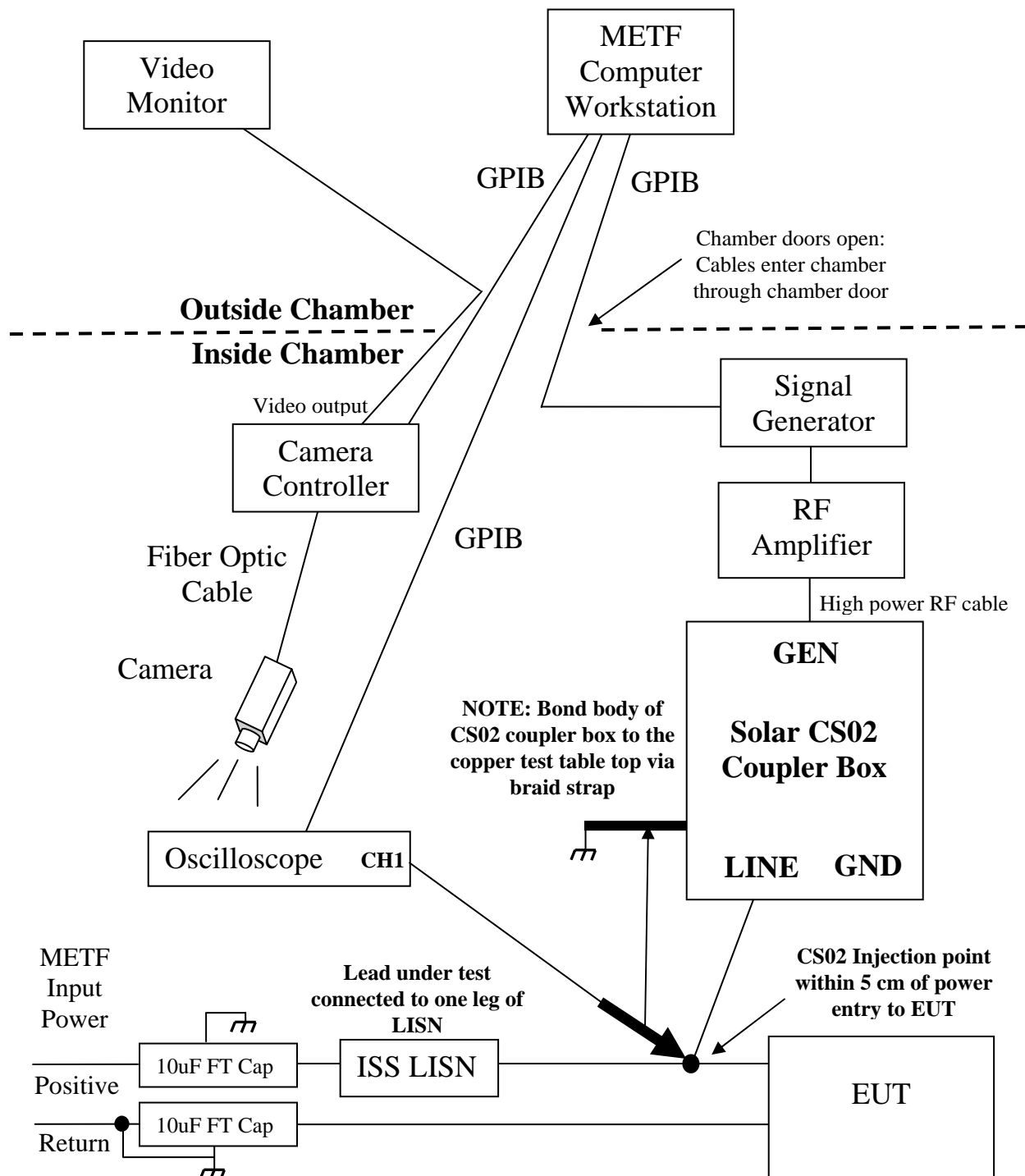


FIGURE CS02-2. CS02 Signal injection.

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6.8 CS06, conducted susceptibility, spikes, power leads.

6.8.1 CS06 applicability.

SSP30237 states that this requirement is applicable to equipment and subsystem dc power leads, including grounds and returns, which are not grounded internally to the equipment or subsystem.

6.8.2 CS06 limit.

SSP30237 states that the EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification when the test spikes, each having the waveform shown in Figure CS06-1 are applied sequentially to the dc power input leads. The values of E and t are shown in Figure CS06-1. Each spike shall be superimposed on the power line voltage waveform. Repetitive (6 to 10 pulses per second) spikes, both positive and negative, shall be applied to the EUT ungrounded input lines for a period of not less than 2 minutes in duration.

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6.8.3 CS06 test procedures.

6.6.3.1 CS06 Purpose.

SSP30238 states that the CS06 test procedure is used to determine equipment susceptibility to spike interference on power leads, including grounds and returns which are not grounded internally to the equipment or subsystem.

6.8.3.2 CS06 Test equipment.

The test equipment will be as follows:

Table CS06-1. METF CS06 Equipment.

Item	METF Equipment
CS06 spike generator	Solar model 8282-1 transient pulse generator, or equivalent
Oscilloscope	Tektronix TDS640A oscilloscope, 500MHz, or equivalent
20 uH inductor	METF small or large 20uH inductor, sized appropriately for EUT current draw
Timer	Kitchen timer capable of counting a 2 minute interval
Connection switch	METF CS06 switch block, or equivalent
Non-inductive 5 ohm resistor	Solar type 8525-1 resistive load, 5 ohms, 5% , 2 watt, or equivalent
Printer	HP inkjet printer, or equivalent
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent

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6.8.3.3 CS06 Setup.

The test setup shall be as follows:

- a. Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and 5.5.
- b. Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- c. Take digital photographs of the CS06 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test. Take photos of the calibration setup as well as the test configuration for each power lead under test.
- d. Calibration:
 - (1) Configure the test equipment as shown in Figure CS06-2.
 - (2) Connect the 5 ohm non-inductive resistor across the parallel terminals of the CS06 pulse generator.
 - (3) Connect the oscilloscope probes across the 5 ohm non-inductive resistor.
- e. EUT Testing:
 - (1) Configure the test equipment as shown in Figure CS06-3. Position the CS06 generator as close to the CS06 injection point as possible.
 - (2) Connect the METF CS06 switch to the CS06 generator parallel terminals using short injection leads.
 - (3) Connect the other side of the METF CS06 switch to the EUT power leads using short injection leads.
 - (4) Connect the oscilloscope probes across the EUT power leads at the CS06 injection point.
- f. Record any deviations from the CS06 calibration or EUT test setup on CS06 deviation sheet(s) as needed.

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6.8.3.4 CS06 Procedures.

The test procedures shall be as follows:

- a.. **NOTE: do not turn on the CS06 generator for at least 30 minutes after the generator has been moved and placed in a normal operating position with the front panel vertical. Some of the mechanical parts must settle to normal attitude before power is applied to the CS06 generator. If power is applied prematurely, these delicate parts will be damaged.**
- b. Turn on the measurement equipment and allow sufficient time for stabilization.
- c. Calibration. Perform the following procedures using the calibration setup for waveform verification.
 - (1) Begin with the following settings on the CS06 generator:
 - (a) Amplitude knob: fully counterclockwise (setting = zero)
 - (b) Frequency pps knob: 1
 - (c) Pulse position knob: fully counterclockwise
 - (d) PPS * 10 button: depressed
 - (e) 10 uS button: depressed
 - (2) Adjust the oscilloscope to capture the 10 usec waveform using a positive trigger slope.
 - (3) Adjust the amplitude of the signal from the CS06 generator to the peak level specified in the requirement. This is the positive 10usec pulse.
 - (4) Record the CS06 generator setting (amplitude Light Emitting Diode (LED) level) in the METF run log on the METF workstation computer, as well as the peak oscilloscope voltage. Print a copy of the waveform from the oscilloscope.
 - (5) Turn the CS06 generator amplitude knob back to zero. Wait until all LEDs on the CS06 generator have gone out before proceeding.
 - (6) Switch polarity on the 5 ohm non-inductive resistor connection to the CS06 generator (rotate 180 degrees). Change the oscilloscope to a negative trigger slope.
 - (7) Adjust the amplitude of the signal from the CS06 generator to the peak level specified in the requirement. This is the negative 10usec pulse.
 - (8) Record the CS06 generator setting (amplitude LED level) in the METF run log on the METF workstation computer, as well as the peak oscilloscope voltage. Print a copy of the waveform from the oscilloscope.

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- (9) Turn the CS06 generator amplitude knob back to zero. Wait until all LEDs on the CS06 generator have gone out before proceeding.
 - (10) Depress the 0.15 uS button on the CS06 generator. Adjust the oscilloscope to capture the 0.15 usec waveform. Change the trigger slope to positive (the 0.15uS pulse is inverted from the 10 uS pulse).
 - (11) Adjust the amplitude of the signal from the CS06 generator to the peak level specified in the requirement. This is the positive 0.15usec pulse.
 - (12) Record the CS06 generator setting (amplitude LED level) in the METF run log on the METF workstation computer, as well as the peak oscilloscope voltage. Print a copy of the waveform from the oscilloscope.
 - (13) Turn the CS06 generator amplitude knob back to zero. Wait until all LEDs on the CS06 generator have gone out before proceeding.
 - (14) Switch polarity on the 5 ohm non-inductive resistor connection to the CS06 generator (rotate 180 degrees). Change the oscilloscope to a negative trigger slope.
 - (15) Adjust the amplitude of the signal from the CS06 generator to the peak level specified in the requirement. This is the negative 0.15usec pulse.
 - (16) Record the CS06 generator setting (amplitude LED level) in the METF run log on the METF workstation computer, as well as the peak oscilloscope voltage. Print a copy of the waveform from the oscilloscope.
 - (17) Turn the CS06 generator amplitude knob back to zero. Wait until all LEDs on the CS06 generator have gone out before proceeding.
- d. EUT testing. Perform the following procedures using the measurement setup for CS06 testing on the EUT.
- (1) Turn on the EUT and measurement equipment to allow sufficient time for stabilization.
 - (2) Begin with the following settings on the CS06 generator:
 - (a) Amplitude knob: fully counterclockwise (setting = zero)
 - (b) Frequency pps knob: 1
 - (c) Pulse position knob: fully counterclockwise
 - (d) PPS * 10 button: depressed
 - (e) 10 uS button: depressed
 - (3) Adjust the oscilloscope to capture the positive 10 usec waveform using a positive trigger slope.

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- (4) Slowly adjust the amplitude of the signal from the CS06 generator to the peak voltage level on the oscilloscope specified in the requirement while monitoring the amplitude LEDs on the CS06 generator. **DO NOT EXCEED THE LED LEVELS ESTABLISHED DURING THE CALIBRATION RUN.**
- (5) Monitor the EUT for degradation of performance. Inject the CS06 signal for two minutes.
- (6) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3 and verify that it is above the specified requirements.
- (7) Record the CS06 generator settings in the METF run log on the METF workstation computer. Print a copy of the waveform from the oscilloscope. This completes the positive 10 usec pulse injection on the lead under test.
- (8) Turn the CS06 generator amplitude knob back to zero. Wait until all LEDs on the CS06 generator have gone out before proceeding.
- (9) Open both legs of the METF CS06 switches. Reverse the leads at the CS06 generator to inject the negative 10 usec pulse. Close both legs of the METF CS06 switch. Change the oscilloscope trigger slope to negative to capture the negative 10 usec pulse.
- (10) Slowly adjust the amplitude of the signal from the CS06 generator to the peak voltage level on the oscilloscope specified in the requirement while monitoring the amplitude LEDs on the CS06 generator. **DO NOT EXCEED THE LED LEVELS ESTABLISHED DURING THE CALIBRATION RUN.**
- (11) Monitor the EUT for degradation of performance. Inject the CS06 signal for two minutes.
- (12) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3 and verify that it is above the specified requirements.
- (13) Record the CS06 generator settings in the METF run log on the METF workstation computer. Print a copy of the waveform from the oscilloscope. This completes the negative 10 usec pulse injection on the lead under test.
- (14) Turn the CS06 generator amplitude knob back to zero. Wait until all LEDs on the CS06 generator have gone out before proceeding.
- (15) Depress the 0.15 uS button on the CS06 generator. Adjust the oscilloscope to capture the 0.15 usec waveform. Change the oscilloscope trigger slope to positive (the 0.15uS pulse is inverted from the 10 uS pulse).

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- (16) Slowly adjust the amplitude of the signal from the CS06 generator to the peak voltage level on the oscilloscope specified in the requirement while monitoring the amplitude LEDs on the CS06 generator. **DO NOT EXCEED THE LED LEVELS ESTABLISHED DURING THE CALIBRATION RUN.**
- (17) Monitor the EUT for degradation of performance. Inject the CS06 signal for two minutes.
- (12) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3 and verify that it is above the specified requirements.
- (13) Record the CS06 generator settings in the METF run log on the METF workstation computer. Print a copy of the waveform from the oscilloscope. This completes the positive 0.15 usec pulse on the lead under test.
- (14) Turn the CS06 generator amplitude knob back to zero. Wait until all LEDs on the CS06 generator have gone out before proceeding.
- (15) Open both legs of the METF CS06 switches. Reverse the leads at the CS06 generator to inject the negative 0.15 usec pulse. Close both legs of the METF CS06 switch. Change the trigger slope to negative to capture the negative 0.15 usec pulse.
- (16) Slowly adjust the amplitude of the signal from the CS06 generator to the peak voltage level on the oscilloscope specified in the requirement while monitoring the amplitude LEDs on the CS06 generator. **DO NOT EXCEED THE LED LEVELS ESTABLISHED DURING THE CALIBRATION RUN.**
- (17) Monitor the EUT for degradation of performance. Inject the CS06 signal for two minutes.
- (18) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3 and verify that it is above the specified requirements.
- (19) Record the CS06 generator settings in the METF run log on the METF workstation computer. Print a copy of the waveform from the oscilloscope. This completes the negative 0.15 usec pulse injection on the lead under test.
- (20) Turn the CS06 generator amplitude knob back to zero. Wait until all LEDs on the CS06 generator have gone out before proceeding.
- (21) Repeat steps 6.8.3.4.d(1) to (21) for the return power lead. In this configuration, the EUT return power lead is the lead under test and is connected to the red parallel terminal of the CS06 generator and the EUT hot lead to the black parallel terminal for both the positive 10 usec and negative 0.15 usec pulses. For the negative 10 usec and positive 0.15 usec pulses, the EUT return lead is connected to the black parallel terminal and the EUT hot lead to the red parallel terminal of the CS06 generator.

CS06

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6.8.3.5. CS06 Data presentation.

Data presentation shall be as follows:

- a. Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.
- b. Provide oscilloscope plots for all calibration runs.
- c. Provide oscilloscope plots for all CS06 injections on the EUT.
- d. Provide data on any susceptibility thresholds that were determined for each power lead.
- e. Provide indications of compliance with the applicable requirements for the susceptibility evaluation specified in 5.4.8.3c for each lead.
- f. Record any deviations from the standard CS06 calibration or EUT test procedures on CS06 deviation sheet(s) as needed.

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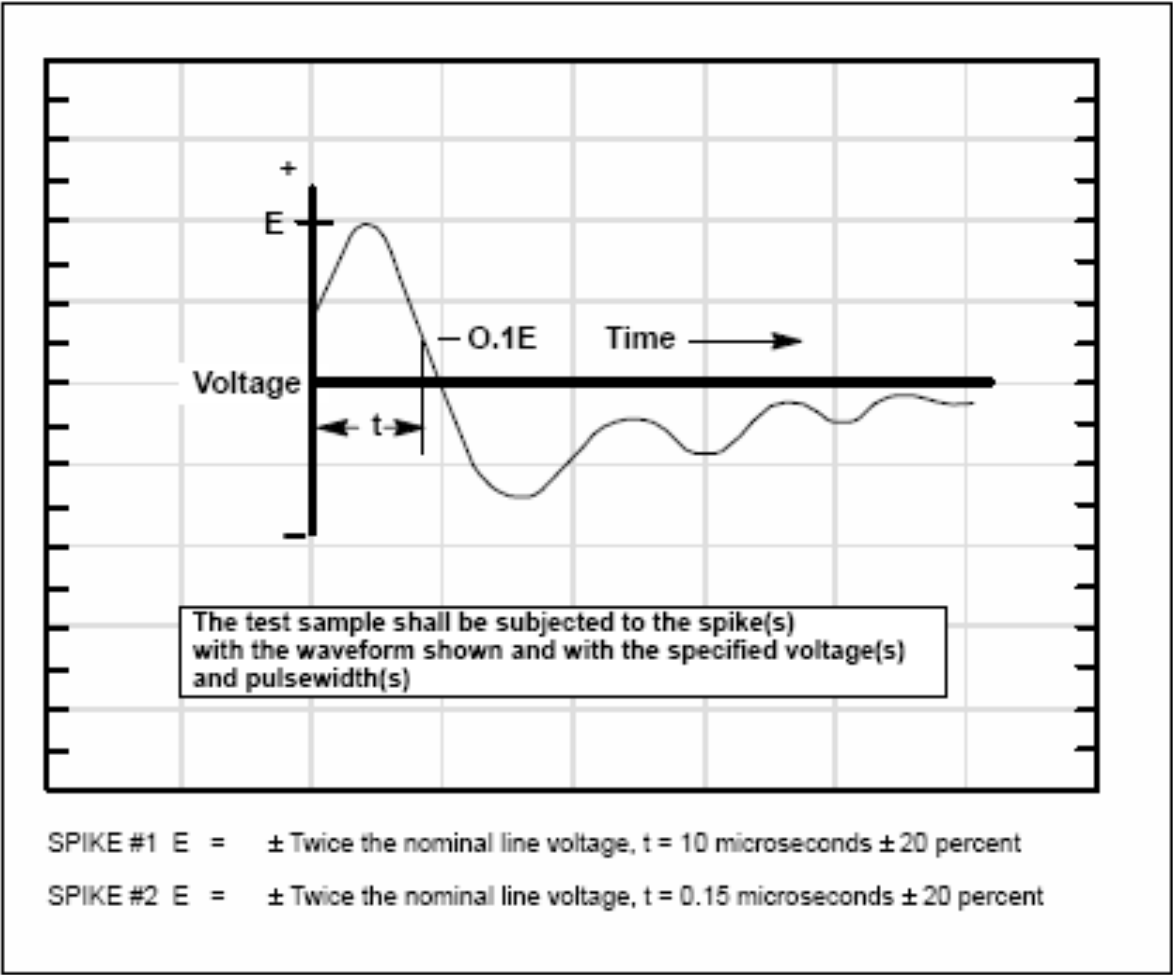


FIGURE CS06-1. CS06 Test waveform and limits.

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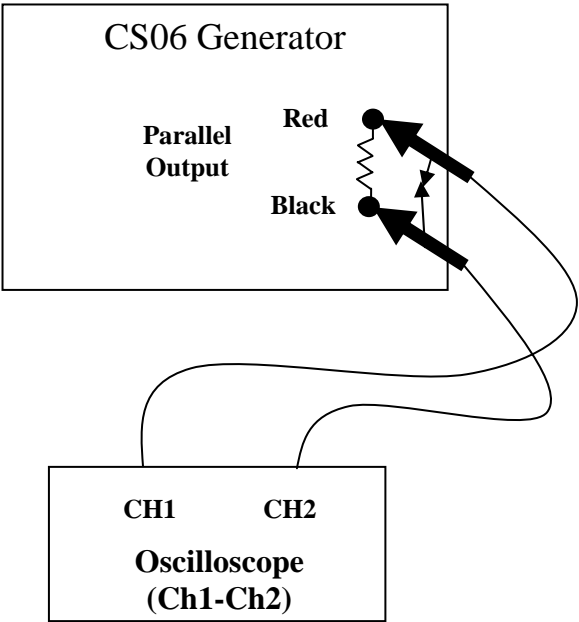


FIGURE CS06-2. Measurement system check setup.

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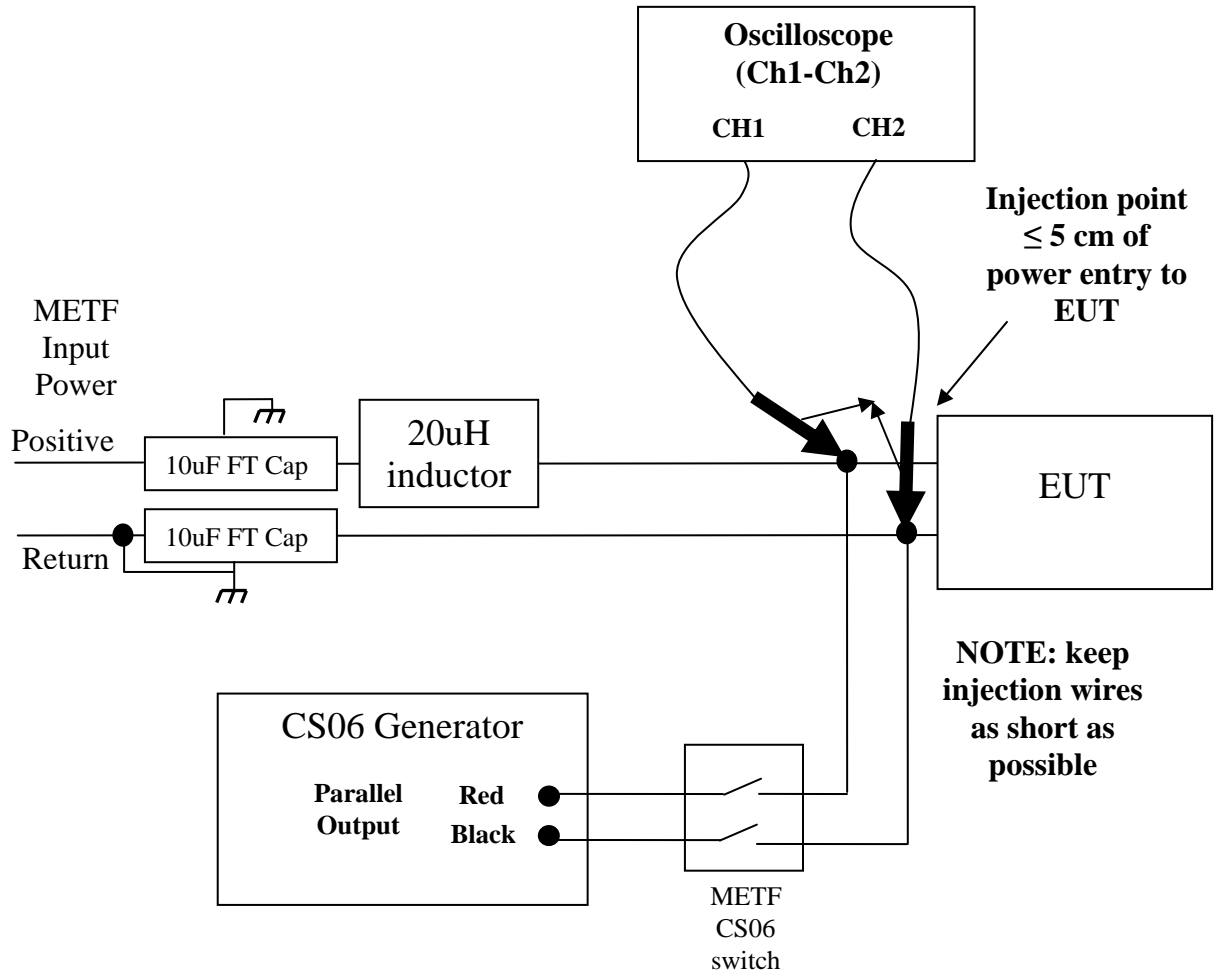


FIGURE CS06-3. Typical test setup for CS06 test.

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6.9 RE02, radiated emissions, electric field, 14 kHz to 10 GHz and 13.5 GHz to 15.5 GHz.

6.9.1 RE02 applicability.

SSP30237 states that this requirement is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, intermediate frequency, power and antenna transmission lines), and interconnecting wiring of the test sample. It applies at the fundamental frequencies and all spurious emissions including harmonics, but does not apply for radiation from antennas. This requirement is applicable for narrowband emissions from 14 kHz to 10 GHz and 13.5 GHz to 15.5 GHz.

6.9.2 RE02 limits.

SSP30237 states that electric field emissions shall not be radiated in excess of those specified in Table RE02-1 and Figure RE02-1 at the required 1 meter test distance. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves. Measurements shall be made in the peak detector mode.

Table RE02-1. RE02 Field Emission Limit.

Frequency	Emission Limit
14 kHz to 10 MHz	56 dBuV/m
10 MHz to 259 MHz	Increasing log linearly with increasing frequency from 56 to 86 dBuV/m (16 dB per decade)
259 MHz to 10 GHz	Increasing log linearly with increasing frequency from 46 to 72 dBuV/m (16 dB per decade)
13.5 GHz to 15.5 GHz	76 dBuV/m

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6.9.3 RE02 test procedures.

6.9.3.1 RE02 Purpose.

SSP30238 states that the RE02 test procedure is used for the measurement of radiated emissions from all equipment and subsystems, cables (including control, pulse, IF, power and antenna transmission lines), and interconnecting wiring of the equipment and subsystems. It applies at the fundamental frequencies and all spurious emissions including harmonics, but does not apply for radiation from antennas.

6.9.3.2 RE02 Test Equipment.

The test equipment will be as follows:

Table RE02-1. METF RE02 Equipment.

Item	METF Equipment
Measurement receiver	Rohde&Schwarz ESI measurement receiver, 20Hz-26.5GHz
Data recording device	Personal computer functioning as data recording device
Test Software	Rohde & Schwarz ES-K1, or equivalent
Rod Antenna (10kHz-30MHz) with impedance matching network and 60cmx60cm counterpoise	EMCO Model 3301B 41" rod antenna, or equivalent
Biconical Antenna (30MHz-200MHz), 137 cm tip to tip	EMCO Model 3104C or equivalent
Double ridge horn (200MHz-1GHz), 69.0cmx94.5cm opening	EMCO Model 3106 or equivalent
Double ridge horn (1GHz-18GHz), 24.2cmx13.6cm opening	EMCO Model 3117 or equivalent
Preamplifier (30MHz-18GHz)	Rohde&Schwarz Model TS-PR18 or equivalent
Signal Generator (<15MHz)	Agilent 33220A, 0.1mHz-15MHz, or equivalent
Signal Generator (>15MHz)	Agilent E8257C, 250kHz – 40GHz, or equivalent
Capacitor, 10pF	METF 10pF calibration fixture
Comb Generator (1MHz-1GHz)	Com-Power CG-501, 1MHz step size
Comb Generator (1GHz-18GHz)	Com-Power CGO-5100, 100MHz step size
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent

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6.9.3.3 RE02 Setup.

The test setup shall be as follows:

- a. Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and 5.5. Ensure that the EUT is oriented such that the surface that produces the maximum radiated emissions is toward the front edge of the test setup boundary. Additional EUT setup clarification from SSP30238 is shown in Figures RE02-2 and RE02-3.
- b. Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- c. Take digital photographs of the RE02 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test. Take photos of each antenna configuration, both vertical and horizontal polarization.
- d. Calibration. Configure the test equipment as shown in Figure RE02-4. Record any deviations from the standard RE02 setup on RE02 deviation page(s) as needed.

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e. EUT testing.

(1) Antenna Positioning.

- (a) Determine the test setup boundary of the EUT and associated cabling for use in positioning of antennas.
- (b) Use the physical reference points on the antennas shown in Figure RE02-5 for measuring heights of the antennas and distances of the antennas from the test setup boundary.
 1. Position antennas 1 meter from the front edge of the test setup boundary for all setups.
 2. Position antennas 120 cm above the floor ground plane.
 3. Ensure that no part of any antenna is closer than 1 meter from the walls and 0.5 meter from the ceiling of the shielded enclosure.
 4. For test setups using bench tops, additional positioning requirements for the antenna and distance above the bench ground plane are shown in Figure RE02-5.
 5. For free standing setups, electrically bond and mount the 104 cm rod antenna matching network to the floor ground plane without a separate counterpoise.
 6. SSP30238 gives additional guidance for the rod antenna counterpoise: the following requirements shall be used when rod antennas that require a counterpoise are used. The test antenna counterpoise shall be referenced to the same ground reference used for the EMI meter. For measurements in shielded enclosures, the counterpoise shall be bonded to the reference ground plane. The bond strap shall be a solid metal sheet having the same width as the counterpoise, welded along the entire edge at points of contact. Alternatively, the counterpoise shall be clamped or soldered to the ground plane in two places. If desired, the counterpoise may be configured so that one dimension is of adequate length to reach the equipment ground plane. For outdoor measurements, the counterpoise and interference analyzer shall be referenced to a good earth ground.

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- (2) The number of required antenna positions depends on the size of the test setup boundary and the number of enclosures included in the setup (reference Figure RE02-6).
 1. For testing from 200 MHz up to 1 GHz, place the antenna in a sufficient number of positions such that the entire width of each EUT enclosure and the first 35 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna.
 2. For testing at 1 GHz and above, place the antenna in a sufficient number of positions such that the entire width of each EUT enclosure and the first 7 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna.
- (3) Record any deviation from the standard RE02 setup on RE02 deviation page(s) as needed.

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6.9.3.4 RE02 Procedures.

The test procedures shall be as follows:

- a. Verify that the ambient requirements specified in 5.3.1 are met. If the emissions with the EUT energized are all below the limit, no ambient measurement is required.
- b. Turn on the measurement equipment and allow a sufficient time for stabilization.
- c. Using the system check path of Figure RE02-4, perform the following evaluation of the overall measurement system from each antenna to the data output device at the highest measurement frequency of the antenna.
 - (1) Apply a calibrated signal level, which is at least 6 dB below the limit (limit minus antenna factor), to the coaxial cable at the antenna connection point.
 - (2) For the 104 cm rod antenna, remove the rod element and apply the signal to the antenna matching network through a 10 pF capacitor connected to the rod mount.
 - (3) Scan the measurement receiver in the same manner as a normal data scan. Verify that the data recording device indicates a level within ± 3 dB of the injected signal level.
 - (4) Record the signal injection level, measured level, and any attenuation used on the signal generator output in the RE02 measurement system spreadsheet on the METF computer workstation. A sample of the spreadsheet is shown in Figure RE02-7.
 - (5) If readings are obtained which deviate by more than ± 3 dB, locate the source of the error and correct the deficiency prior to proceeding with the testing.
 - (6) Record any deviations from the standard RE02 calibration procedure on RE02 deviation page(s) as needed.
- d. Using the measurement path of Figure RE02-4, perform the following evaluation for each antenna to demonstrate that there is electrical continuity through the antenna.
 - (1) Radiate a signal using the applicable comb generator (1MHz to 18GHz).
 - (2) Scan the measurement receiver for each applicable frequency range, using the bandwidths and minimum measurement times in Table III. Verify that a received signal of appropriate amplitude is present. Note: This evaluation is intended to provide a coarse indication that the antenna is functioning properly. There is no requirement to accurately measure the signal level. Record the verification results in Table RE02-2.

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Table RE02-2. Antenna check results

Frequency	Antenna Continuity (Yes/No)	Print/Plot Number
30 MHz (rod)		
200 MHz (biconical)		
1G (large horn)		
18G (small horn)		

- e. Turn on the EUT and allow sufficient time for stabilization.
- f. Using the measurement path of Figure RE02-4, determine the radiated emissions from the EUT and its associated cabling.
 - (1) Scan the measurement receiver for each applicable frequency range, using the bandwidths and minimum measurement times in Table III.
 - (2) Orient the antennas for both horizontally and vertically polarized fields.
 - (3) Take measurements for each antenna position determined under 6.9.3.3e(2) above.
- g. Record any deviations from the standard RE02 EUT test procedure on RE02 deviation page(s) as needed.

6.9.3.5 RE02 Data Presentation.

Data presentation shall be as follows:

- a. Continuously and automatically plot amplitude versus frequency profiles. Manually gathered data is not acceptable except for plot verification. Vertical and horizontal data for a particular frequency range shall be presented on separate plots or shall be clearly distinguishable in black or white format for a common plot.
- b. Display the applicable limit on each plot.
- c. Provide a minimum frequency resolution of 1% or twice the measurement receiver bandwidth, whichever is less stringent, and a minimum amplitude resolution of 1 dB for each plot.
- d. Provide plots for both the measurement and system check portions of the procedure.
- e. Complete Table RE02-2 to verify the electrical continuity of the measurement antennas as determined in 6.9.3.4d.
- f. Include the completed METF RE02 measurement system spreadsheet with the test data.
- g. Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.

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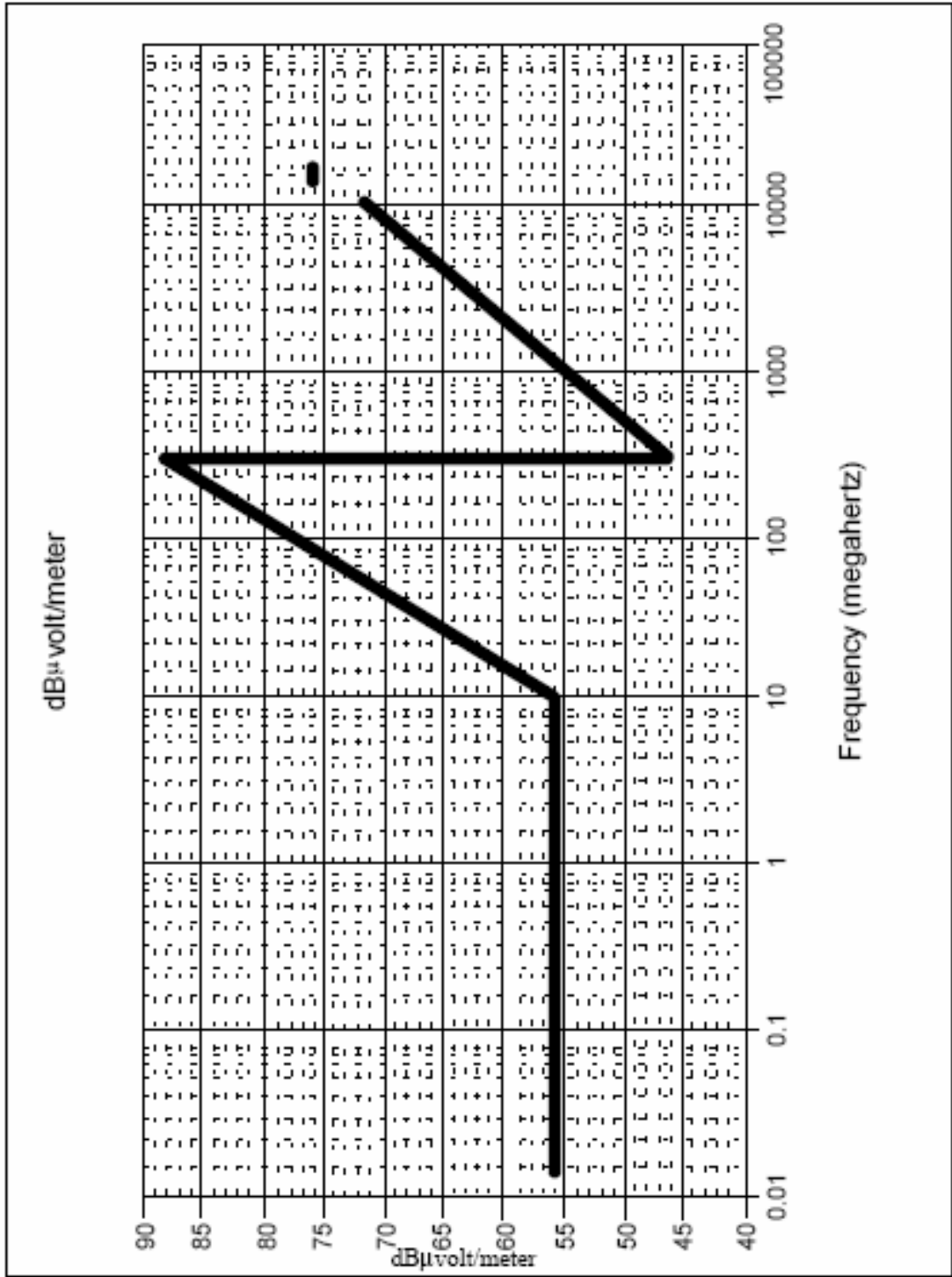


FIGURE RE02-1. ISS Emission Limits.

RE02

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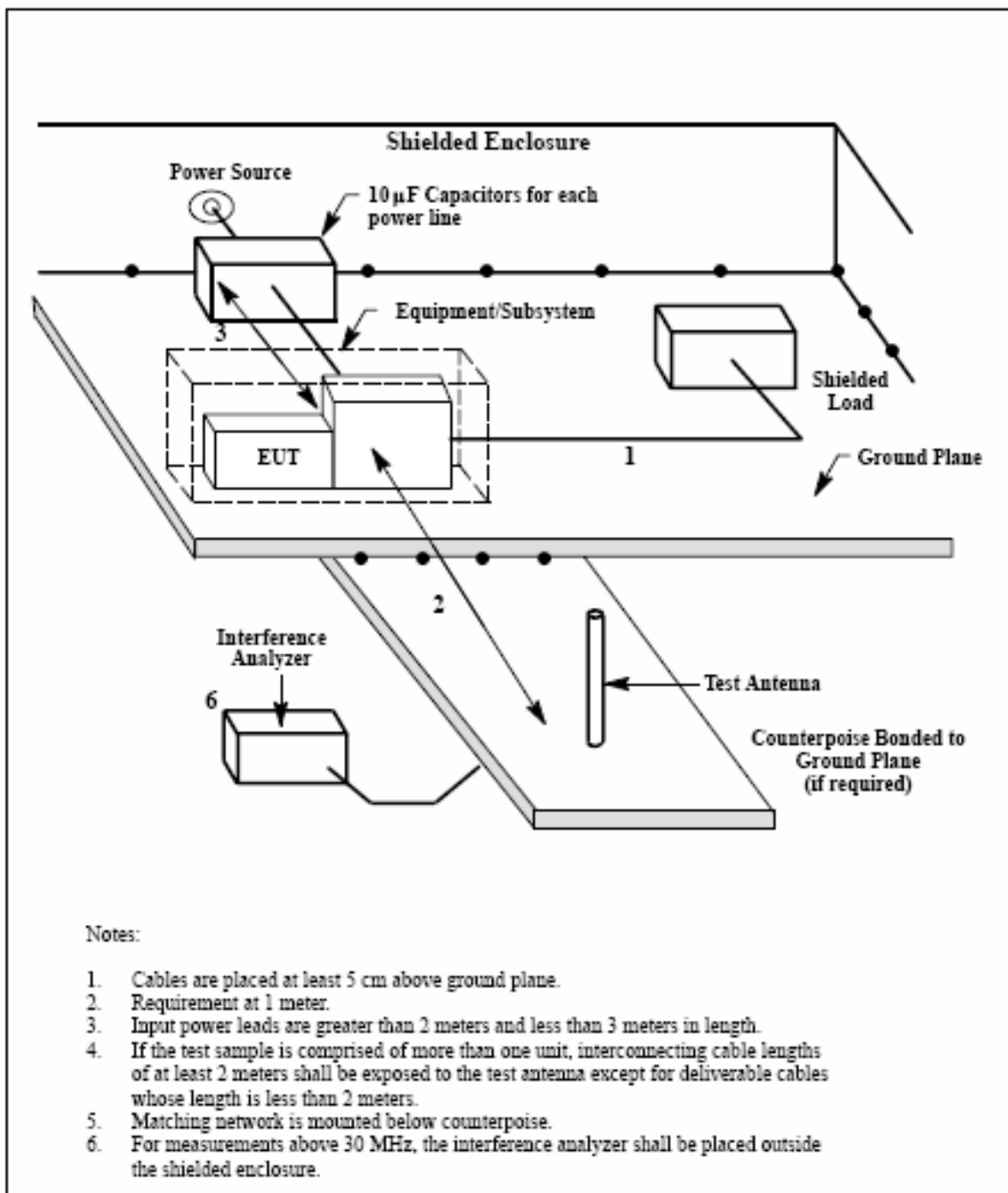


FIGURE RE02-2. SSP32038 typical test setup for RE02.

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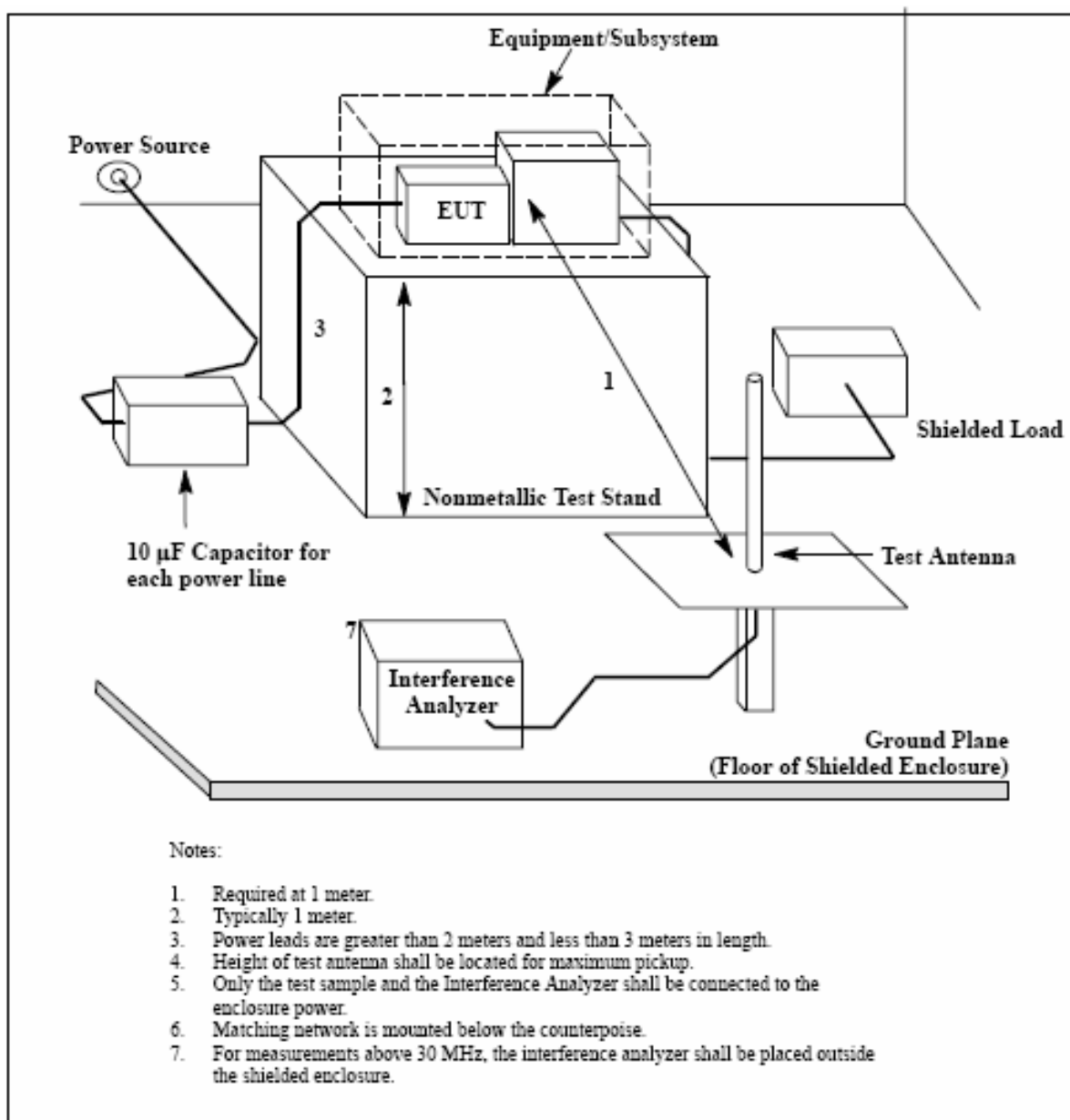


FIGURE RE02-3. SSP30238 typical test setup for RE02 on portable equipment.

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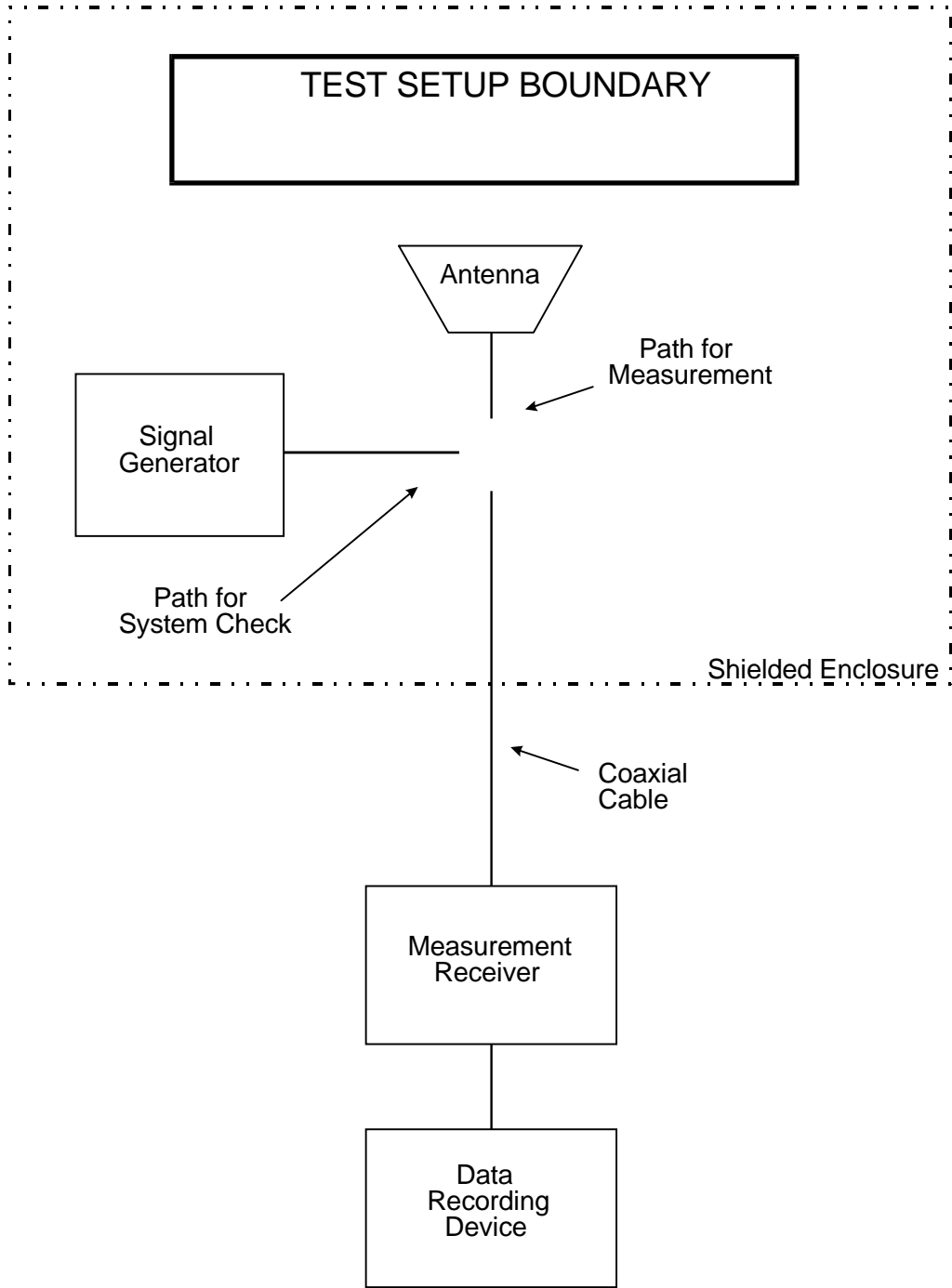


FIGURE RE02-4. Basic test setup.

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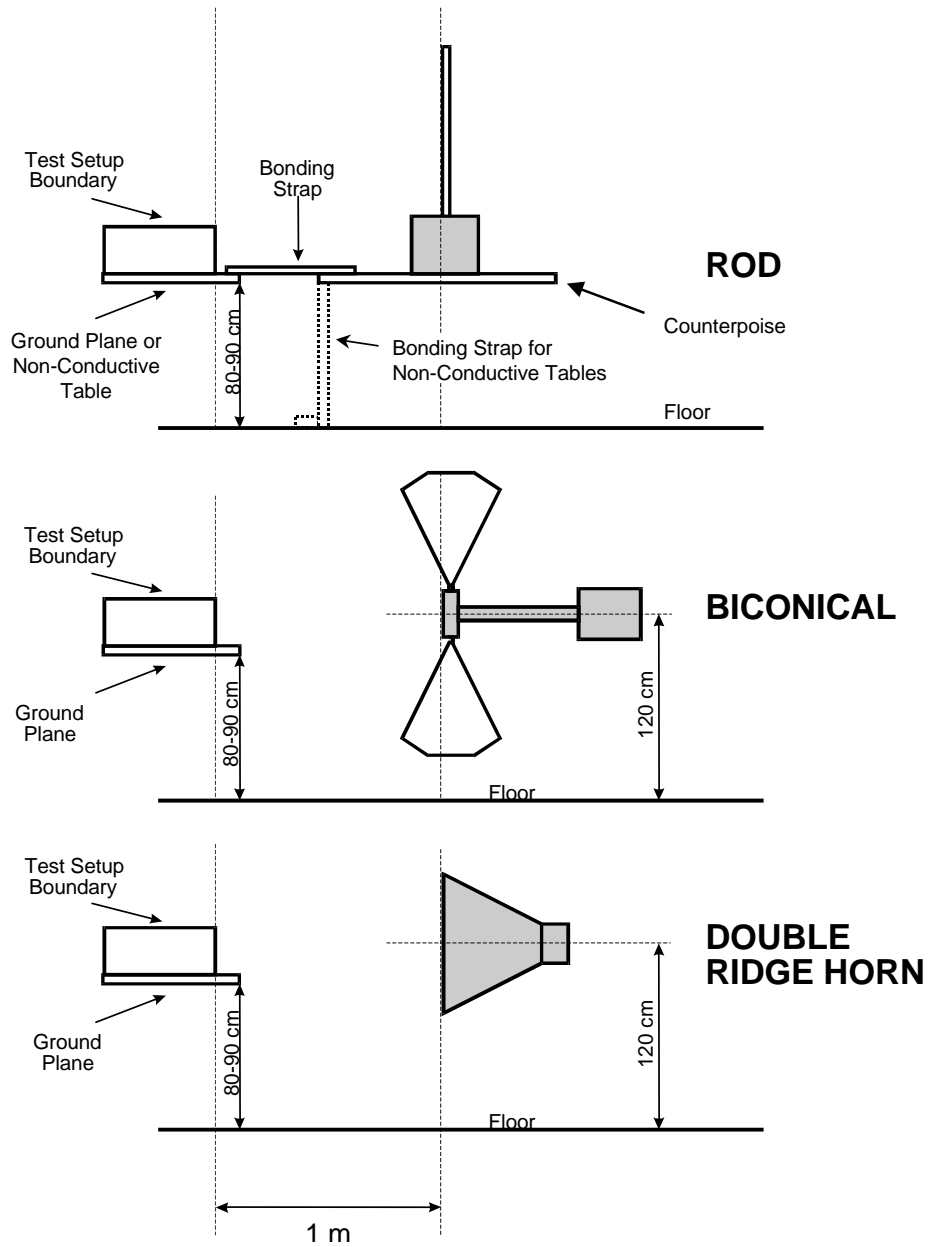


FIGURE RE02-5. Antenna positioning.

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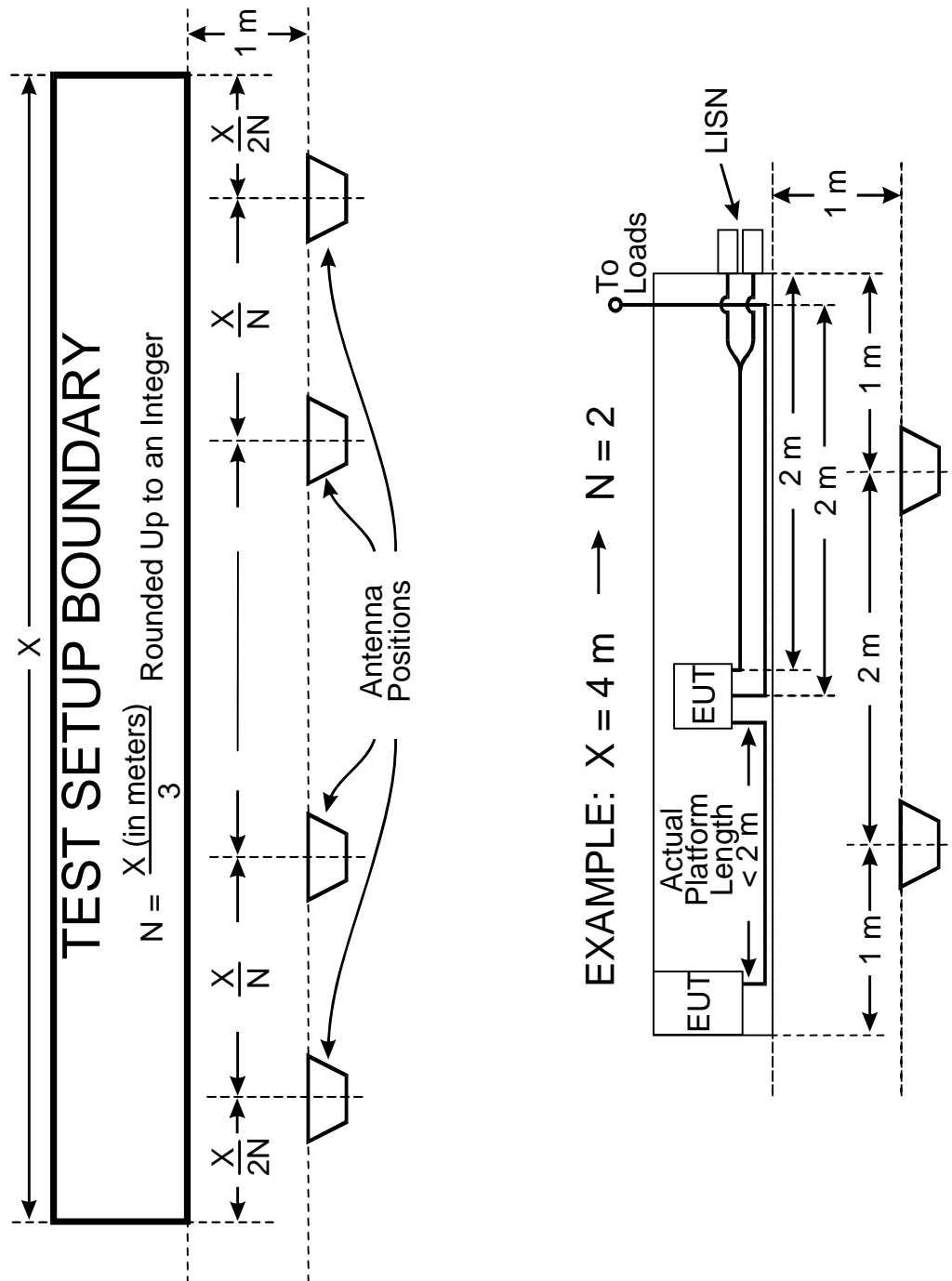


FIGURE RE02-6. Multiple antenna positions.

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SSP30237 RE02 Inputs for System Checkout

EUT: Sample

Date: 1-May-06

****Correct antenna factors input for this test

YES

Spec: SSP30237 (ISS)

Freq (MHz)	Spec Amplitude (dBμV/m)	Target Amplitude (dBμV/m)	Antenna ID	Antenna Conversion Factor (dB)	Input Level (dBμV)	Input Level (dBm)	Measure d Level (dBμV/m)	Margin (dB)	Comments	Sig gen
Large DRG horn										
200	83.62	77.62	3106/ 2562	10.5	67.12	-39.88	78.04	0.42		E8257C
259	46	40	3106/ 2562	12.1	27.9	-79.1	40.46	0.46		E8257C
300	47.05	41.05	3106/ 2562	12.5	28.55	-78.45	41.66	0.61		E8257C
400	49.09	43.09	3106/ 2562	13.6	29.49	-77.51	43.55	0.46		E8257C
500	50.68	44.68	3106/ 2562	16.7	27.98	-79.02	44.96	0.28		E8257C
600	51.98	45.98	3106/ 2562	17.7	28.28	-78.72	46.28	0.3		E8257C
700	53.08	47.08	3106/ 2562	17.9	29.18	-77.82	47.36	0.28		E8257C
800	54.03	48.03	3106/ 2562	19.3	28.73	-78.27	48.57	0.54		E8257C
900	54.86	48.86	3106/ 2562	21.6	27.26	-79.74	49.19	0.33		E8257C
1000	55.61	49.61	3106/ 2562	22.8	26.81	-80.19	49.84	0.23		E8257C

FIGURE RE02-7. Sample METF RE02 Measurement System Spreadsheet

RE02

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6.10 RS02, radiated susceptibility, magnetic induction fields.

6.10.1 RS02 applicability.

SSP30237 states that this requirement is applicable for all equipment and subsystems. These susceptibility signals are electromagnetically coupled into the equipment or subsystem wiring.

6.10.2 RS02 limit.

SSP30237 states that the EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification when subjected sequentially to the test spikes, each having the waveform shown in Figure RS02-1. The values of E and t are shown in Figure RS02-1.

Repetitive (400 pulses per second, or at the maximum rate which can be achieved with the RS02 generator) spikes, both positive and negative, shall be applied for a period of not less than 2 minutes in duration. Power input and output leads are exempt from this test. It is not intended that individual wires be tested but rather that wire bundles configured per Space Station installation drawings be tested. The injection period shall be sufficient to check all EUT operational modes for susceptibility, but not less than two minutes per injection.

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6.10.3 RS02 test procedures.

6.10.3.1 RS02 Purpose.

SSP30238 states that the RS02 test procedure is used to determine equipment susceptibility of cable connected equipment to short duration, fast risetime induction fields electromagnetically coupled into the equipment through the wiring connecting equipment.

6.10.3.2 RS02 Test equipment.

The test equipment will be as follows:

Table RS02-1. METF RS02 Equipment.

Item	METF Equipment
RS02 spike generator	Solar model 8282-1 transient pulse generator, or equivalent
Oscilloscope	Tektronix TDS640A oscilloscope, 500MHz, or equivalent
Timer	Kitchen timer capable of counting a 2 minute interval
RS02 injection wires	Insulated AWG 12 wires
10 ohm resistor	Dale 10 ohm 250W, or equivalent
Printer	HP inkjet printer, or equivalent
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent

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6.10.3.3 RS02 Setup.

The test setup shall be as follows:

- a. Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and 5.5.
- b. Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- c. Take digital photographs of the RS02 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test. Take photos of the configuration for each cable under test.
- d. Calibration: there is no calibration required for RS02.
- e. EUT Testing:
 - (1) Configure the test equipment as shown in Figure RS02-2. Position the RS02 generator near the EUT.
 - (2) Connect the out-going injection wire to the RS02 generator red parallel terminal. Beginning 15cm from the connector on the EUT end of the cable under test, tie wrap the injection wire to the cable under test. Continue tie wrapping the injection wire to the cable under test at sufficient intervals to ensure that the injection wire is close to the cable under test and follows any bends in the cable.
 - (3) After tie wrapping the injection wire to the cable under test for a distance equal to the lesser of the cable length in the actual installation or 1.5 meters, connect the injection wire to one side of the 10 ohm resistor.
 - (4) Connect the return injection wire to the other side of the 10 ohm resistor. Make as small a loop as possible between the out-going and return injection wires as the return injection wire is run back and connected to the RS02 generator black parallel terminal.
 - (5) An alternate test procedure shall be used for any cable under test with a diameter greater than 1 cm. A second injection wire is tie wrapped to the cable under test 180 degrees around the cable periphery from the first injection wire (i.e., on the opposite side of the cable under test from the first injection wire). The RS02 injection is performed sequentially on each wire: only inject on one injection wire connected to the 10 ohm resistor at a time. Simultaneous injection on both wires is not allowed. Label the two injection wires with colored electrical tape (e.g. red and blue) to tell them apart and notate the METF run log with which injection wire is being used for a given run. **Make sure the injection wire under test is connected to the 10 ohm resistor.**
 - (6) Connect the oscilloscope probes across the 10 ohm resistor.

RS02

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6.10.3.4 RS02 Procedures.

The test procedures shall be as follows:

- a.. **NOTE: do not turn on the RS02 generator for at least 30 minutes after the generator has been moved and placed in a normal operating position with the front panel vertical. Some of the mechanical parts must settle to normal attitude before power is applied to the RS02 generator. If power is applied prematurely, these delicate parts will be damaged.**
- b. Turn on the measurement equipment and allow sufficient time for stabilization.
- c. EUT testing. Perform the following procedures using the measurement setup for RS02 testing on the EUT.
 - (1) Turn on the EUT and measurement equipment to allow sufficient time for stabilization.
 - (2) Begin with the following settings on the RS02 generator:
 - (a) Amplitude knob: fully counterclockwise (setting = zero)
 - (b) Frequency pps knob: 4 (ensure this value is selected)**
 - (c) Pulse position knob: fully counterclockwise
 - (d) PPS * 10 button: depressed
 - (e) 10 uS button: depressed
 - (3) Adjust the oscilloscope to capture the positive 10 usec waveform using a positive trigger slope.
 - (4) Slowly adjust the amplitude of the signal from the RS02 generator to the peak voltage level specified in the requirement while monitoring the peak voltage on the oscilloscope.
 - (5) Monitor the EUT for degradation of performance. Inject the RS02 signal for two minutes.
 - (6) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3 and 6.10.3.4.c(29).
 - (7) Record the RS02 generator settings in the METF run log on the METF workstation computer. Print a copy of the waveform from the oscilloscope. This completes the positive 10 usec pulse injection on the cable under test.
 - (8) Turn the RS02 generator amplitude knob back to zero. Wait until all LEDs on the RS02 generator have gone out before proceeding.

RS02

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- (9) Reverse the injection wire leads at the RS02 generator to inject the negative 10 usec pulse. Change the oscilloscope trigger slope to negative to capture the negative 10 usec pulse.
- (10) Slowly adjust the amplitude of the signal from the RS02 generator to the peak voltage level specified in the requirement while monitoring the peak voltage on the oscilloscope.
- (11) Monitor the EUT for degradation of performance. Inject the RS02 signal for two minutes.
- (12) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3 and 6.10.3.4.c(29).
- (13) Record the RS02 generator settings in the METF run log on the METF workstation computer. Print a copy of the waveform from the oscilloscope. This completes the negative 10 usec pulse injection on the cable under test.
- (14) Turn the RS02 generator amplitude knob back to zero. Wait until all LEDs on the RS02 generator have gone out before proceeding.
- (15) Depress the 0.15 uS button on the RS02 generator. Adjust the oscilloscope to capture the 0.15 usec waveform. Change the trigger slope to positive (the 0.15uS pulse is inverted from the 10 uS pulse).
- (16) Slowly adjust the amplitude of the signal from the RS02 generator to the peak voltage level specified in the requirement while monitoring the peak voltage on the oscilloscope.
- (17) Monitor the EUT for degradation of performance. Inject the RS02 signal for two minutes.
- (18) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3 and 6.10.3.4.c(29).
- (19) Record the RS02 generator settings in the METF run log on the METF workstation computer. Print a copy of the waveform from the oscilloscope. This completes the positive 0.15 usec pulse on the cable under test.
- (20) Turn the RS02 generator amplitude knob back to zero. Wait until all LEDs on the RS02 generator have gone out before proceeding.
- (21) Reverse the injection wire leads at the RS02 generator to inject the negative 0.15 usec pulse. Change the trigger slope to negative to capture the negative 0.15 usec pulse.
- (22) Slowly adjust the amplitude of the signal from the RS02 generator to the peak voltage level specified in the requirement while monitoring the peak voltage on the oscilloscope.

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- (23) Monitor the EUT for degradation of performance. Inject the RS02 signal for two minutes.
- (24) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3 and 6.10.3.4.c(29).
- (25) Record the RS02 generator settings in the METF run log on the METF workstation computer. Print a copy of the waveform from the oscilloscope. This completes the negative 0.15 usec pulse injection on the cable under test.
- (26) Turn the RS02 generator amplitude knob back to zero. Wait until all LEDs on the RS02 generator have gone out before proceeding.
- (27) Repeat steps 6.10.3.4.c(1) to (20) for the second injection wire on cables with diameter greater than 1 cm.
- (28) Repeat steps 6.10.3.4.c(1) to (20) for each EUT cable under test.
- (29) Any EUT susceptibility is a function of both the current in the injection wire and the separation of the injection wire from the cable under test. The RS02 susceptibility shall be specified in two ways.
 - (a) The RS02 spike amplitude shall be diminished until the threshold is reached. Record that spike amplitude.
 - (b) Move the injection wire a small distance from the cable under test. Repeat the RS02 injection at this new test distance and determine the susceptibility amplitude threshold at this new distance. If the cable under test is comprised of many bundle classes, the most sensitive bundle class in the cable under test shall be used to determine the separation.

6.10.3.5. RS02 Data presentation.

Data presentation shall be as follows:

- a. Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.
- b. Provide oscilloscope plots for all RS02 injections on the EUT.
- c. Provide data on any susceptibility thresholds that were determined for each power lead.
- d. Provide indications of compliance with the applicable requirements for the susceptibility evaluation specified in 5.4.8.3c for each lead.
- e. Record any deviations from the standard RS02 EUT test procedures on RS02 deviation sheet(s) as needed.

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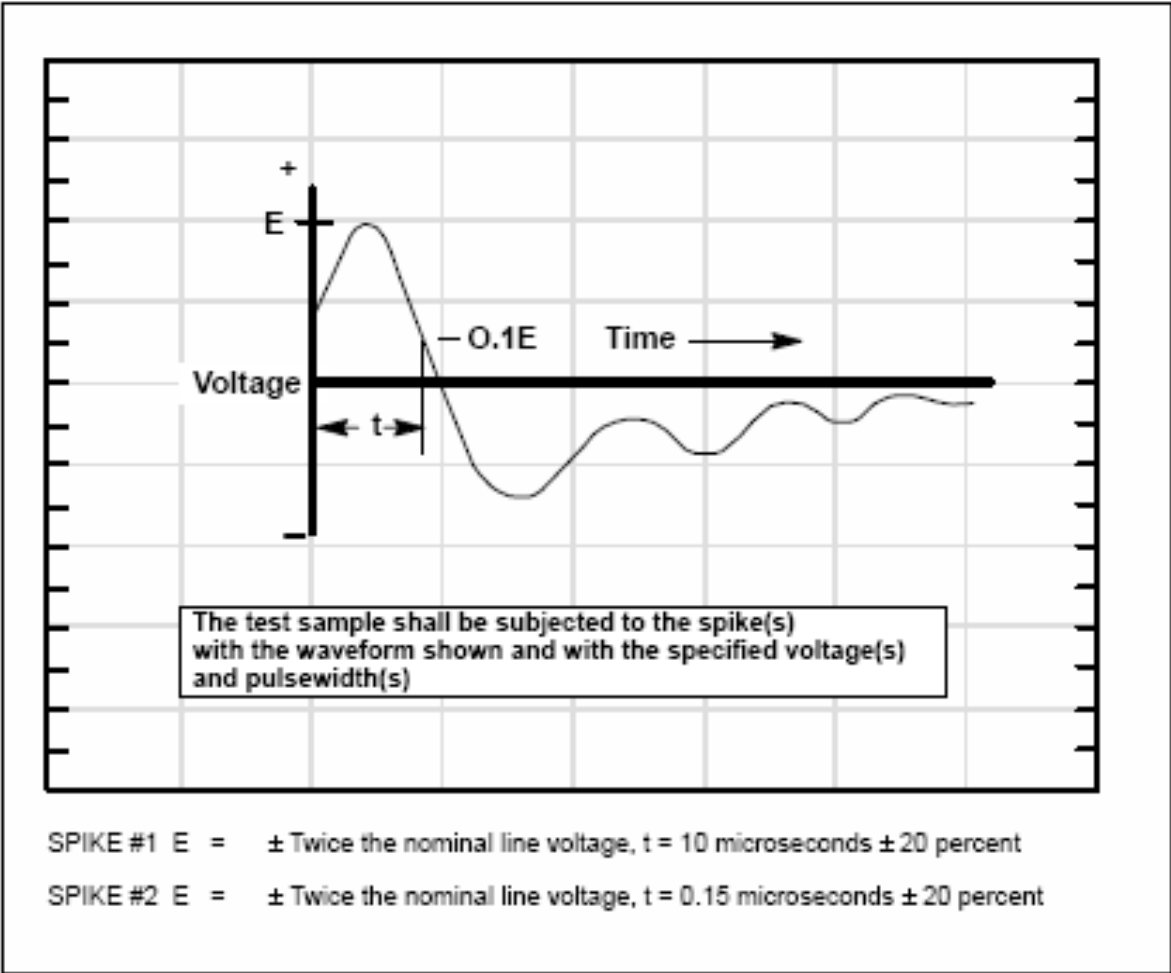


FIGURE RS02-1. RS02 Test waveform and limits.

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L is the length of the cable in the actual installation or 1.5 meters, whichever is less

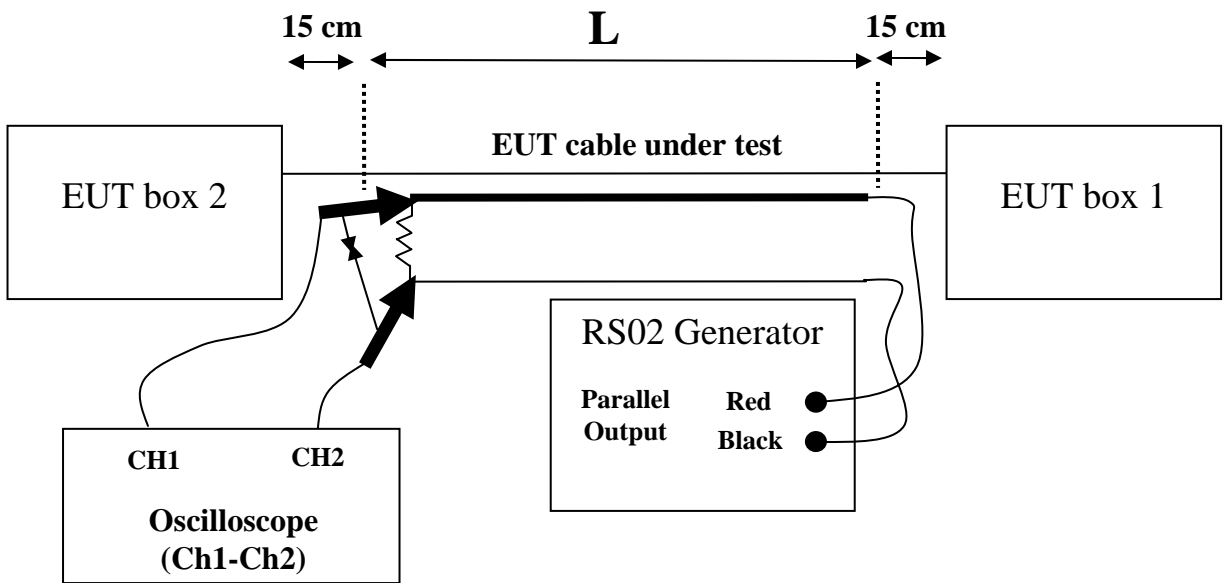


FIGURE RS02-2. Typical test setup for RS02 test.

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6.11 RS03, radiated susceptibility, electric field, 14 kHz to 10 GHz and 13.7 GHz to 15.2 GHz.

6.11.1 RS03 applicability.

SSP30237 states that this requirement is applicable for all equipment and subsystems between 14kHz and 20 GHz. Above 10 GHz, this requirement applies only at specific frequencies and amplitudes known to be present at the Space Station. Below 10 GHz, this requirement shall be increased only at specific frequencies and amplitudes known to be present at the ISS. Module shielding effectiveness can be used to limit the levels applied.

6.11.2 RS03 limit.

SSP30237 states that the EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the radiated electric fields listed in Table RS03-1. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves. As a minimum, the levels shown in Table RS03-1 apply at either the specified frequencies stated or across the ranges stated.

Table RS03-1. RS03 limit levels.

Frequency	Radiated Electric Field Level (V/m)
14 kHz – 200 MHz	5
200 MHz – 8 GHz	60
8 GHz – 10 GHz	20
2.2 GHz	161
8.5 GHz	79
13.7 GHz – 15.2 GHz	250

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6.11.3 RS03 Minimum criteria for signal modulation.

SSP30238 states that the test signals shall be modulated according to the following minimum criteria for testing performed using the standard test frequencies.

6.11.3.1 Equipment under test with audio channels/receivers.

- a. Amplitude modulation (AM) receivers: modulate 50 percent with a 1000 Hz sine wave.
- b. Frequency modulation (FM) receivers: when monitoring signal to noise ratio, modulate with a 1000 Hz sine wave using 10 kHz deviation. When monitoring receiver quieting, use no modulation.
- c. Single side band receivers: use on modulation.
- d. Other equipment: same as for AM receivers.

6.11.3.2 Equipment under test with video channels other than receivers.

SSP30238 stipulates modulate 90 to 100 percent with pulse of duration two per bandwidth and repetition rate equal to bandwidth/1000 where bandwidth is the video bandwidth.

6.11.3.3 Digital equipment.

SSP30238 stipulates pulse modulation with pulse duration and repetition rates equal to that used in the EUT.

6.11.3.4 Nontuned equipment.

SSP30238 stipulates 50 percent amplitude modulation with a 1000 Hz sine wave.

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6.11.4 RS03 test procedures.

6.11.4.1 RS03 Purpose.

SSP30238 states that the RS03 test procedure is used to verify the ability of the EUT and associated cabling to withstand electric fields.

6.11.4.2 RS03 Test Equipment.

The test equipment will be as follows:

Table RS03-2. METF RS03 Equipment.

Item	METF Equipment
Low frequency signal generator	Agilent 33220A, 0.1mHz-15MHz, or equivalent
High frequency signal generator	Agilent E8257C, 250kHz – 40GHz, or equivalent
Amplifier (14kHz-220MHz)	AR 150A220 or AR 250A250A or equivalent
Amplifier (80MHz-1GHz)	AR 100W1000M3 or AR 250W1000A or equivalent
Amplifier (1GHz-2.8GHz)	AR 200T1G3A, or equivalent
Amplifier (2.8GHz-7.5GHz)	AR 200T2G8AM3, or equivalent
Amplifier (7.5GHz-18GHz)	AR 250T8G18, or equivalent
E-Field Generator (14kHz-30MHz)	AR AT3000, or equivalent
Transmit Antenna (30MHz-200MHz)	ETS-Lindgren 3109XP, or equivalent
Transmit Antenna (200MHz-1GHz)	EMCO 3106, or equivalent
Transmit Antenna (1GHz-18GHz)	EMCO 3115, or equivalent
Electric Field Sensor (14kHz-1GHz)	AR FP5000, or equivalent
Electric Field Sensor (80MHz-40GHz)	AR 2080 or ARFP5080, or equivalent
10uF Feed-through capacitors (One on each power lead)	Solar Type 6512-106R, or equivalent
Test Software	Total Integrated Laboratory Environment (TILE), or equivalent

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6.11.4.3 RS03 Setup.

The test setup shall be as follows:

- a. Maintain a basic test setup for the EUT as shown and described in Figures 3 through 6 and 5.5.
- b. Enter the calibration data on the calibration sheets in Appendix A for all calibrated equipment to be used for the test.
- c. Take digital photographs of the RS03 test configuration to document the setup. Take sufficient photographs to show all relevant details of the test. Take photos of each antenna configuration, both vertical and horizontal polarization.

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d. EUT testing.

- (1) Placement of electric field sensors: Position sensors 1 meter from, and directly opposite, the transmit antenna as shown in Figures RS03-2 and RS03-3 and a minimum of 30 cm above the ground plane. Do not place sensors directly at corners or edges of EUT components.
- (2) Placement of transmit antennas. Antennas shall be placed 1 meter from the test setup boundary as follows:
 - (a) 14kHz to 200 MHz
 - 1 Test setup boundaries ≤ 3 meters. Center the antenna between the edges of the test setup boundary as shown in Figure RS03-1. The boundary includes all enclosures of the EUT and the 2 meters of exposed interconnecting and power leads required in 5.5. Interconnecting leads shorter than 2 meters are acceptable when they represent the actual platform installation.
 - 2 Test setup boundaries > 3 meters. Use multiple antenna positions (N) at spacings as shown in Figure RS03-3. The number of antenna positions (N) shall be determined by dividing the edge-to-edge boundary distance (in meters) by 3 and rounding up to an integer.
 - (b) 200 MHz and above. Multiple antenna positions may be required as shown in Figure RS03-2. Determine the number of antenna positions (N) as follows:
 - 1 For testing from 200 MHz up to 1 GHz, place the antenna in a sufficient number of positions such that the entire width of each EUT enclosure and the first 35 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna.
 - 2 For testing at 1 GHz and above, place the antenna in a sufficient number of positions such that the entire width of each EUT enclosure and the first 7 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna.

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6.11.4.4. RS03 Procedures.

The test procedures shall be as follows:

- a. Turn on the measurement equipment and EUT and allow a sufficient time for stabilization.
- b. Assess the test area for potential RF hazards and take necessary precautionary steps to assure safety of test personnel.
- c. Record the amplitude shown on the electric field sensor display unit due to EUT ambient. Reposition the sensor, as necessary, until this level is < 10% of the applicable field strength to be used for testing.
- d. EUT Testing.
 - (1) Set the signal source to continuous wave (CW) modulation and using the appropriate amplifier and transmit antenna, establish an electric field at the test start frequency. Gradually increase the electric field level until it reaches the applicable limit in Table RS03-1. Once the required field intensity is reached with continuous wave (CW) modulation, then turn on the applicable signal source modulation as specified in paragraph 6.11.3 for the required dwell time.
 - (2) Scan the required frequency ranges in accordance with the rates and durations specified in Table IV. Maintain field strength levels in accordance with the applicable limit. Monitor EUT performance for susceptibility effects.
 - (3) If susceptibility is noted, determine the threshold level in accordance with 5.4.8.3c.
 - (4) Perform testing over the required frequency range with the transmit antenna vertically polarized. Repeat the testing with the transmit antenna horizontally polarized for test frequencies above 30MHz.
 - (5) Repeat steps (1) to (4) for each transmit antenna position required by 6.11.4.3d.

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6.11.4.5 RS03 Data Presentation.

Data presentation shall be as follows:

- a. Provide graphical or tabular data showing frequency ranges and field strength levels tested.
- b. Provide graphs or tables listing any susceptibility thresholds that were determined along with their associated frequencies. Record the test results in the test run log spreadsheet on the METF computer workstation.
- c. Provide diagrams or photographs showing actual equipment setup and the associated dimensions.
- d. Complete the frequency step size column in Table RS03-3 and red-line the equipment configuration as needed to document the METF equipment configuration used for each RS03 frequency range.
- e. Record results in the test run log spreadsheet on the METF computer workstation and in Table VI EUT tests performed and test results.

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Table RS03-3. METF RS03 typical test equipment configuration.

Frequency Range (Hz)	Signal Generator	Frequency step size	Target E-field (V/m)	Antenna	Amplifier	Field probe(s)
14 kHz to 250 kHz	Agilent 33220A	0._____ f _o	5	AR AT3000	AR 250A250A	AR5000 (2)
250 kHz to 1 MHz	Agilent E8257C	0._____ f _o	5	AR AT3000	AR 250A250A	AR5000 (2)
1 MHz to 30 MHz	Agilent E8257C	0._____ f _o	5	AR AT3000	AR 250A250A	AR5000 (2)
30 MHz to 200 MHz	Agilent E8257C	0._____ f _o	5	ETS 3109XP Large biconical	AR 250A250A	AR5000 (2)
200 MHz to 1 GHz	Agilent E8257C	0._____ f _o	60	EMCO 3106 Large horn	AR 250W1000A	AR5000 (2)
1 GHz to 2.5 GHz	Agilent E8257C	0._____ f _o	60	ETS 3115 Small horn	AR 200T1G3A	AR 5080 (2) or AR 2080 (2)
2.2 GHz	Agilent E8257C	N/A	161	ETS 3115 Small horn	AR 200T2G8AM3	AR 5080 (2) or AR 2080 (2)
2.5 GHz to 7.5 GHz	Agilent E8257C	0._____ f _o	60	ETS 3115 Small horn	AR 200T2G8AM3	AR 5080 (2) or AR 2080 (2)
7.5 GHz to 8 GHz	Agilent E8257C	0._____ f _o	60	ETS 3115 Small horn	AR 250T8G18	AR 5080 (2) or AR 2080 (2)
8 GHz to 10 GHz	Agilent E8257C	0._____ f _o	20	ETS 3115 Small horn	AR 250T8G18	AR 5080 (2) or AR 2080 (2)
8.5 GHz	Agilent E8257C	N/A	79	ETS 3115 Small horn	AR 250T8G18	AR 5080 (2) or AR 2080 (2)
13.7 GHz to 15.2 GHz	Agilent E8257C	0._____ f _o	250	ETS 3115 Small horn	AR 250T8G18	AR 5080 (2) or AR 2080 (2)

RS03

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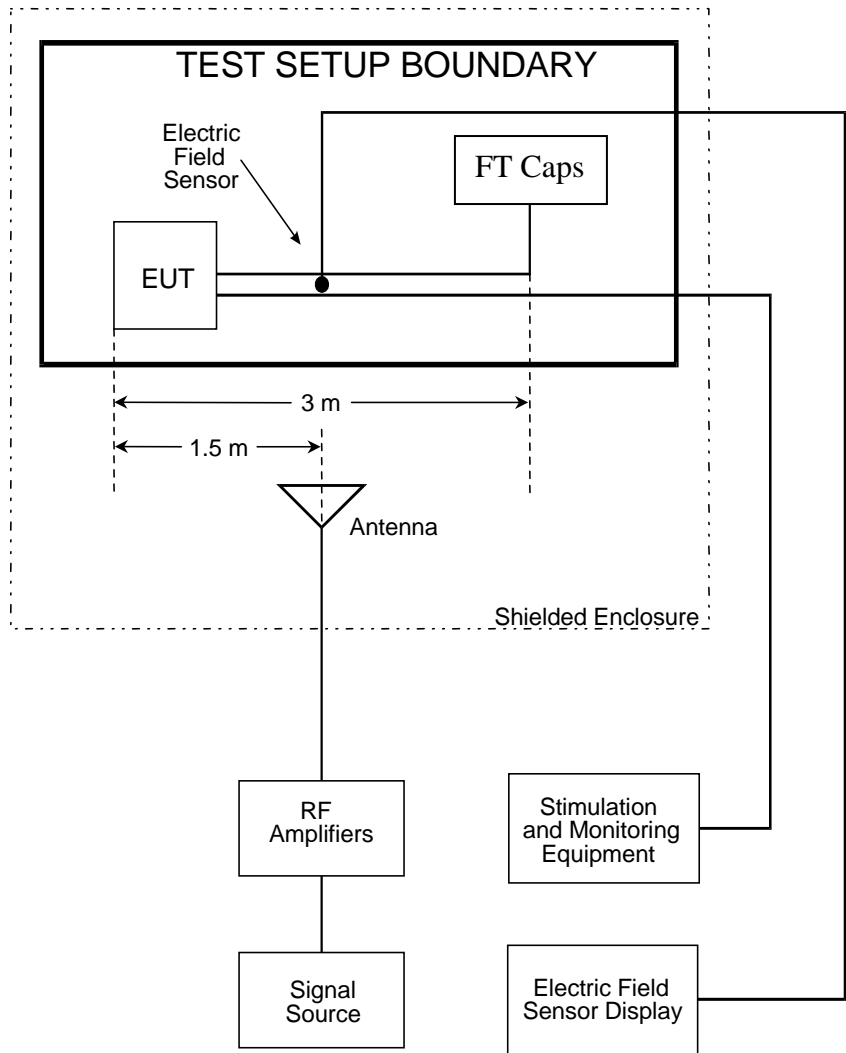


FIGURE RS03-1. Test equipment configuration.

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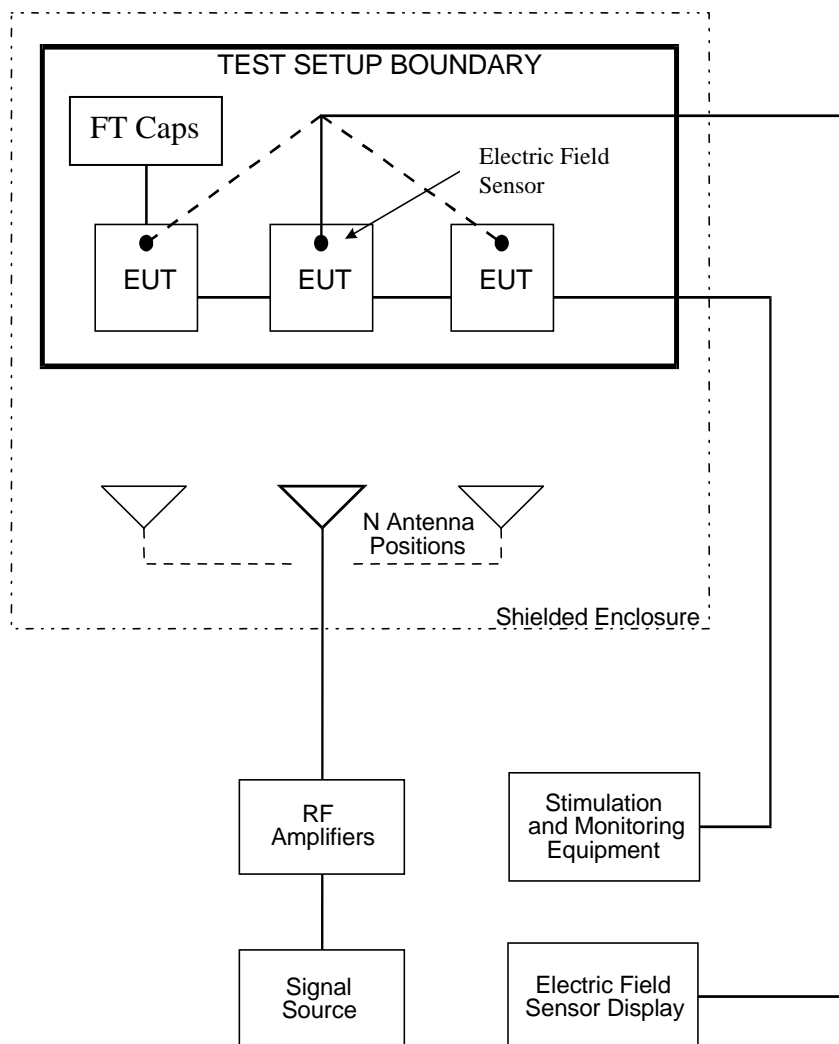


FIGURE RS03-2. Multiple test antenna locations for frequency > 200 MHz.

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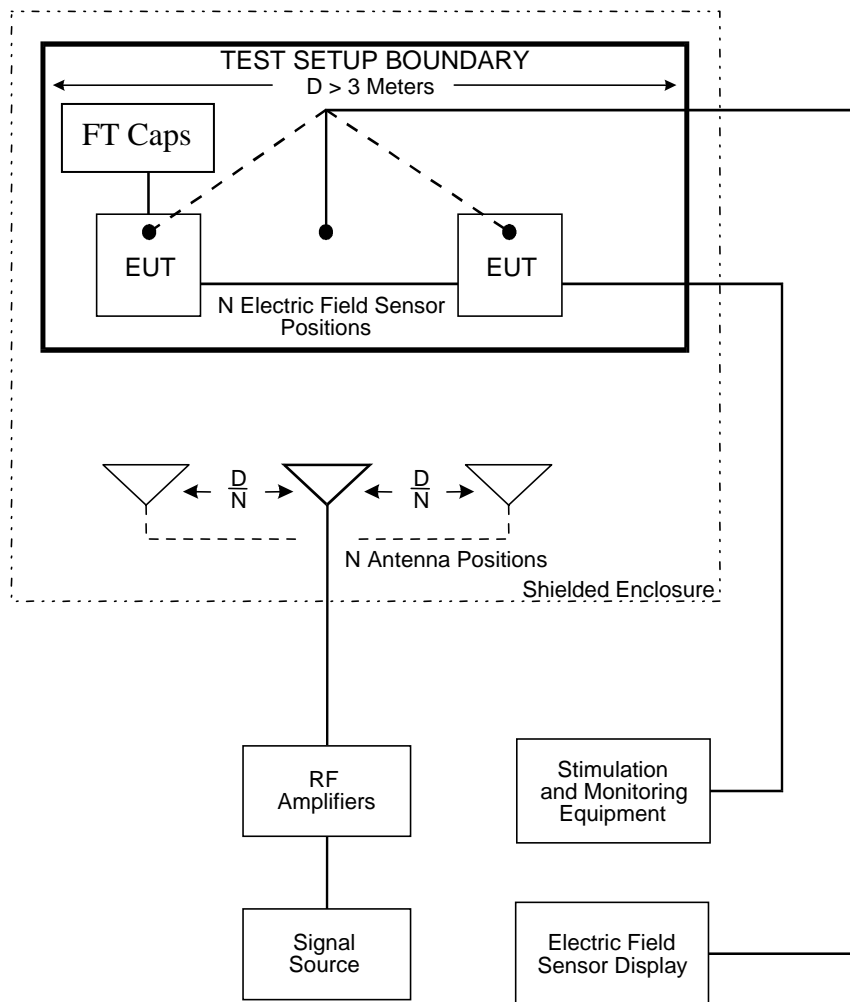


FIGURE RS03-3. Multiple test antenna locations for N positions, $D > 3$ meters.

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Appendix A

NASA MSFC EMI Test Facility (METF) Test Preparation and Equipment Calibration Log

Sheet 1 of 8

CA Start Date: _____

Setup Date: _____

Start of test Date: _____

End of test Date : _____

Project Name: _____

EUT Product Number: _____ **EUT S/N:** _____

METF Customer Agreement Form (CAF) #: _____

EMI Test Requirements Document: _____

Customer Supplied Product (CSP) Tag #: _____

EUT EMI Test Preparations:

1. EUT bonding to ground plane measurement: _____ mOhm (≤ 2.5 mohm)

Other bonding values : _____

2. EUT measured current draw: _____

	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
3. Install power fuse as required:	____A	____A	____A	____A	____A

4. METF Power Supply voltage:	Feed 1	Feed 2	Feed 3	Feed 4	Feed 5
Unloaded value:	____Vdc	____Vdc	____Vdc	____Vdc	____Vdc
Loaded value:	____Vdc	____Vdc	____Vdc	____Vdc	____Vdc

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5. 10 ufarad feed-through capacitors used in interfacing with power supply shall be bonded to ground plane. (Unless requirements call for change in ground setup.)

10 ufarads grounded to ground plane: Yes ___ No ___
Value _____mOhm

Reason for deviation:

6. Take digital photographs of the general test configuration to document the setup. Take sufficient photographs to show all relevant details of the test, including the ground support equipment (GSE) configuration.

Photographs completed _____

7. Perform a "total calibration" on the Rohde and Schwarz EMI receiver prior to performing any emissions measurements.

Receiver calibration completed _____

8. EUT configured per the general test setups of Figures 4-7 in this FOP.

- a. All sides of EUT at least 30 cm from test chamber wall _____
- b. Front of EUT located 10cm from ground plane front edge _____
- c. EUT safety grounds connected to ground plane (if applicable) _____
- d. Interconnecting leads/cables (ILC) elevated 5 cm off gnd plane _____
- e. ILC at front of table 10cm back from edge _____
- f. At least 2 meters of each ILC parallel to table front edge _____
- g. ILC longer than 10 meters, at least 10 meters tested _____
- h. Remaining ILC lengths routed to back and zig-zagged _____
- i. Individual ILCs separated by 2 cm _____
- j. ILCs leaving test chamber have cable shield bonded to chamber _____
- k. Power leads (PL) elevated 5 cm off ground plane _____
- l. PL at front of table 10 cm back from edge _____
- m. At least 2 meters of each PL parallel to table front edge _____
- n. For bundled PL, 2 meters parallel to table front edge and then broken out and routed to LISN in as short a distance as possible _____
- o. Total PL length less than 2.5 meters _____
- p. Each PL (hot, return, neutral) connected to a 10uF capacitor _____

Deviations from the above requirements: _____

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Current Measurement Probes

CE01 Current Probe	PCL-10 S/N 1617	M636810	_____
CE01 Current Probe	PCL-10 S/N 128-A	M646442	_____
CE01 Current Probe	PCL-10 S/N 4-0101	M646497	_____
CE01 Current Probe	PCL-10 S/N 4-0104	M648433	_____
CE03 Current Probe	CP-105 S/N 175	M644315	_____
CE03 Current Probe	CP-105 S/N 555	M646496	_____
RF Current Probe	Solar 6741-1	M649672	_____
RF Current Probe	Solar 6741-1	M650552	_____
RF Current Probe	Solar 6741-1	M649609	_____
RF Current Probe	Solar 9123-1N	M650517	_____
RF Current Probe	Solar 9123-1N	M650518	_____
RF Current Probe	EMCO 91550-2	M639667	_____
RF Current Probe	EMCO 91550-2BL	M636916	_____
RF Current Probe	EMCO 94111-1L	M640777	_____

Antennas

RE02 Antenna (rod, 14k – 30M)	3301B S/N 2795	M632231	_____
RE02 Antenna (rod, 14k – 30M)	3301B S/N 3752	1727810	_____
RE02 Antenna (rod, 14k – 30M)	3301B S/N 2796	M637005	_____
RE02 Antenna (Biconical, 30-220M)	BIA-30S S/N 160	M650934	_____
RE02 Antenna (Biconical, 30-220M)	EMCO 3104C S/N4919	M651418	_____
RE02 Antenna (DRG, 200M-2G)	3106 S/N 2562	M651458	_____
RE02 Antenna (DRG, 200M-2G)	3106 S/N 2729	1963110	_____
RE02 Antenna (DRG, 1-18G)	3115 S/N 5631	M642380	_____
RE02 Antenna (DRG, 1-18G)	3115 S/N 4230	M651306	_____
RE02 Antenna (DRG, 1-18G)	3115 S/N 27001	M651068	_____
RE02 Antenna (DRG, 1-18G)	3115 S/N 27016	M651067	_____
RE02 Antenna (DRG, 1-18G)	3117 S/N 52313	M655134	_____
RE02 Antenna (DRG, 1-18G)	3117 S/N 52312	M655135	_____

RE102 BCE Clamps

RE102 BCE Absorbing Clamp	FCC F-201-23mm S/N 130	M653760	_____
RE102 BCE Absorbing Clamp	FCC F-201-23mm S/N 87	F-201-23SN87	_____
RE102 BCE Absorbing Clamp	FCC F-201-23mm S/N 129	M653759	_____

Pre-amplifiers

Pre-Amplifier	R&S TS-PR18 (SN 001)	2510382	_____
Pre-Amplifier	R&S TS-PR18 (SN 002)	M654732	_____
Pre-Amplifier	R&S TS-PR18 (SN 100017)	1667072	_____

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EMI Receivers/Spectrum Analyzers

EMI Test Receiver	R/S ES126 S/N 001	2015727	_____
EMI Test Receiver	R/S ES126 S/N 002	2015728	_____
Spectrum Analyzer	HP 8590L	1535135	_____
Spectrum Analyzer	HP 8591E	1279517	_____
Spectrum Analyzer	HP 8566B	835331	_____
Spectrum Analyzer Display	HP 85662A	835332	_____

E-field Sensors

E-field Sensor (10k-1G)	AR FP5000 S/N 28495	2015540	_____
E-field Sensor (10k-1G)	AR FP5000 S/N 28496	2015541	_____
E-field Sensor (10k-1G)	AR FP5000 S/N 308151	308151	_____
E-field Sensor (10k-1G)	AR FP5000 S/N 308190	3054636	_____
Isotropic Field Probe (80M-40G)	AR FP2080 S/N300564	2017452	_____
Isotropic Field Probe (80M-40G)	AR FP2080 S/N300467	2017451	_____
Isotropic Field Probe (80M-40G)	AR FP5080 S/N 309517	3054633	_____
Isotropic Field Probe (80M-40G)	AR FP5080 S/N 309520	3054634	_____

Rack mount multimeters

Digital Multimeter	HP 3455A	676443	_____
Digital Multimeter	HP3458A	1153180	_____

Handheld multimeters/Current probes

Digital Multimeter (handheld)	Fluke 87	M624653	_____
Digital Multimeter	Fluke 73 III	M648654	_____
Digital Multimeter	Fluke 73 III	M648781	_____
AC/DC Current Probe	Fluke i410	M644165	_____
AC/DC Current Probe	Fluke i410	M654313	_____
Digital Multimeter (handheld)	Fluke 867B	M636809	_____
Digital Multimeter (handheld)	Fluke 867B	M647219	_____

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<u>Oscilloscope and Probe Sets</u>			
Digital Oscilloscope	Tek TDS 640A	1962460	_____
10X 500MHz probe	Tek P6139A	M647225	_____
10X 500MHz probe	Tek P6139A	M650710	_____
10X 500MHz probe	Tek P6139A	M650932	_____
10X 500MHz probe	Tek P6139A	M647224	_____
10X 500MHz probe	Tek P6139A	M653770	_____
Digital Oscilloscope	Tek TDS5104B	3053305	_____
10X 500MHz probe	Tek P5050	M653750	_____
10X 500MHz probe	Tek P5050	M653751	_____
10X 500MHz probe	Tek P5050	M653752	_____
10X 500MHz probe	Tek P5050	M653753	_____
Digital Oscilloscope	Tek TDS5104B	3053118	_____
10X 500MHz probe	Tek P5050	M653631	_____
10X 500MHz probe	Tek P5050	M653632	_____
10X 500MHz probe	Tek P5050	M653633	_____
10X 500MHz probe	Tek P5050	M653634	_____
Handheld Scope	Tek THS720A	M651413	_____
10X 200MHz probe	Tek P6117	M653768	_____
10X 200MHz probe	Tek P6117	M653769	_____
Handheld Scope	Tek THS720A	M653273	_____
10X 200MHz probe	Tek P6117	M653275	_____
10X 200MHz probe	Tek P6117	M653767	_____
Handheld Scope	Tek THS730A	M653766	_____
10X 200MHz probe	Tek P6117	M653765	_____
10X 200MHz probe	Tek P6117	M653766	_____

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<u>Microohm Meters</u>			
Microohm Meter	Keithley 580	M651647	_____
Microohm Meter	Keithley 580	M652544	_____
Microohm Meter	Keithley 580	M652263	_____
<u>Gaussmeters and Probes</u>			
DC Magnetic Gaussmeter	FW Bell 9640	M651415	_____
DC Gaussmeter 3 Axis Probe	FW Bell S/N 303404	M651414	_____
DC Magnetic Gaussmeter	FW Bell 9950	2015567	_____
DC Gaussmeter 3 Axis Probe	FW Bell S/N 294601	M647993	_____
<u>LISNs</u>			
SSP30237 ISS LISN, 50A	Solar 9238-10-TS-50	M636920	_____
SSP30237 ISS LISN, 50A	Solar 9238-10-TS-50	M646547	_____
MSFC-SPEC-521B LISN, 30A	Solar 2122-4-TS-30-BNC	M648869	_____
MSFC-SPEC-521B LISN, 30A	Solar 2122-4-TS-30-BNC	M650004	_____
MSFC-SPEC-521B LISN, 50A	Solar 2123-4-TS-50-BNC	M650005	_____
MSFC-SPEC-521B LISN, 50A	Solar 2123-4-TS-50-BNC	M648983	_____
MIL-STD-461E LISN, 24A	Solar 8028-50-TS-24-BNC	M650555	_____
MIL-STD-461E LISN, 24A	Solar 8028-50-TS-24-BNC	M650556	_____
MIL-STD-461D LISN, 100A	Solar 8116-50-TS-100-N	S/N 972052	_____
MIL-STD-461D LISN, 100A	Solar 8116-50-TS-100-N	S/N 974706	_____
MIL-STD-461D LISN, 200A	Solar 9331-50-TS-200-N	S/N 981917	_____
MIL-STD-461D LISN, 200A	Solar 9331-50-TS-200-N	S/N 981918	_____
<u>Signal Generators</u>			
Synthesizer/ Function Gen	Agilent 33220A	M653773	_____
Synthesizer/ Function Gen	Agilent 33220A	M654896	_____
Synthesizer/ Function Gen	Agilent E8257C	3052021	_____
Synthesizer/ Function Gen	HP 83620B	1895123	_____

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<u>Power Meters</u>			
Power Meter Set #1	Boonton 5232	M651694	_____
Power Sensor Set #1	Boonton 51011-EMC	M650451	_____
Power Sensor Set #1	Boonton 51011-EMC	M650450	_____
RF Probe Set #1	Boonton 952001B	M650453	_____
RF Probe Set #1	Boonton 952016	M653775	_____
Power Meter Set #2	Boonton 5232	M653272	_____
Power Sensor Set #2	Boonton 51011-EMC	M649236	_____
Power Sensor Set #2	Boonton 51011-EMC	M649237	_____
RF Probe Set #2	Boonton 952001B	M652298	_____
<u>Differential scope probes</u>			
Differential Probe	Tek P5205 SN: B018399	M649623	_____
Differential Probe	Tek P5205 SN: B018346	M649624	_____
Differential Probe	Tek P5205 SN: B017288	M649436	_____
Differential Probe	Tek P5205 SN: B020810	M652222	_____
<u>Miscellaneous</u>			
High Voltage Attenuator	Solar 9410-1	M650519	_____
High Voltage Attenuator	Solar 9410-1	M650520	_____
CSO2 Coupler Box	Solar 7415-3	METF955917	_____
CSO2 Coupler Box	Solar 7415-3	METF955944	_____
20uH air core inductor	High current	METF01	_____
20uH air core inductor	Low current	METF02	_____
Directional Coupler	Werlatone C5086	M653772	_____
Directional Coupler	Werlatone C5086	M654897	_____
Directional Coupler	Werlatone C5086	M654898	_____

EI24 Test Conductor : _____ **Date :** _____

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